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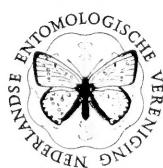


Volume 133

1990

Tijdschrift voor Entomologie

A journal of systematic and evolutionary
entomology since 1858



Published by the Nederlandse Entomologische Vereniging

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Editorial

The editors of the 'Tijdschrift voor Entomologie' proudly present herewith the first issue of volume 133, complete with a new cover design and a reshaped graphic page design.

Both the cover and the lay-out were designed by Aad Derwort of the Dutch firm 'Ontwerpers', The Hague. The cover depicts a variety of insects from a collection of illustrations for graphic designers and illustrates the variety of topics covered. The logo of the Netherlands Entomological Society can still be found on the new cover, albeit somewhat smaller. This logo, in use since 1953, depicts the Large copper (*Lycaena dispar batavus* Oberthür) on top of its greatly enlarged egg. The logo was introduced on the cover of volume 96 when the late Alex Diakonoff became the managing editor.

The lay-out of the articles has undergone relatively small changes compared with previous issues.

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The new design parallels changes in the editorial policy of the 'Tijdschrift' to transform it into an international journal of systematic and evolutionary entomology. Although the journal has been published for an international audience for several decades, the Dutch language was still used on the cover and elsewhere. This has now all been translated into English, except the journal's title which has become too well-known to be changed. Furthermore the editors now explicitly express preference for articles on the insect fauna of the Palaearctic and Indo-Australian regions. Papers on other regions are in principle only accepted if space allows or if the paper deals with a topic of broader interest.

Some changes have gradually been introduced in the last three volumes. The system of publishing a number of issues per year with one article each was left in favour of two issues with various contents. This has reduced the expenses and has given the opportunity to accept also short papers and book reviews. The journal will usually be published around June 1st and December 1st. The editors regret that the present issue appears some weeks late.

As can also be seen in this issue, the 'Tijdschrift' is certainly not only a medium for Dutch entomologists or for members of the Netherlands Entomological Society alone. Authors from all countries are cordially invited to submit their papers. Only quality and consistency with the scope play a role in acceptance, although we would certainly welcome new members of the society. It is general policy now to invite external referees to review the manuscripts with regard to their scientific quality and soundness. A new set of instructions for authors will be published in the next issue and a guide for preparation of manuscripts on diskette will be distributed on request.

The 'Tijdschrift voor Entomologie' has a long tradition and is certainly one of the oldest entomological journals still being published. The journal has been

published annually since 1858, accounting for a total of 132 volumes up to now. In the early days mainly the Dutch language was used. Later French, German and English gradually started to play a role. In the second half of this century Dutch lost its position as a scientific language and disappeared from the journal. From the start the journal has especially served as a medium for systematic entomology and, until the fifties, also for Dutch faunistics. Prior to 1953 it also included the proceedings of the meetings of the Netherlands Entomological Society. Faunistic papers, articles in the Dutch language and smaller papers of international interest are now being published in 'Entomologische Berichten' (Entomological Reports), another society journal. Other publications of the Society are the international journal 'Entomologia experimentalis et applicata' and the monograph series 'Monografieën van de Nederlandse Entomologische Vereniging'.

The editors hope that the new face of the journal will please the readers and especially that the contents, which is after all the most important part of a journal, will continue to find their way to the professional and amateur entomologist.

Erik J. van Nieukerken
Jan van Tol
[editors]

A. W. M. Mol
R. T. A. Schouten
[co-editors]

NABICULA (LIMNONABIS) PROPINQUA (REUTER)
(HETEROPTERA: NABIDAE): DIMORPHISM,
PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY

Asquith, A. & J. D. Lattin, 1990. *Nabicula (Limnonabis) propinqua* (Reuter) (Heteroptera: Nabidae): dimorphism, phylogenetic relationships and biogeography. – Tijdschrift voor Entomologie 133: 3-16, figs. 1-15, tabs. 1-3. [ISSN 0040-7496]. Published 31 July 1990.

The taxonomy and distribution of the North American species *Nabicula propinqua* (Reuter), is reviewed. The macropterous form occurs in both sexes, but is much less common than the brachypterous form. Macropterous forms of both sexes have wider pronota. Males have disproportionately longer antennae than females. Male and female genitalia of *N. propinqua* are described and illustrated. The genitalia of individuals from isolated west coast populations differ only slightly from those of eastern populations. A cladistic analysis of the subgenus *Limnonabis* Kerzhner is presented and a new species-group classification suggested. A biogeographic hypothesis explaining the present distribution of *Limnonabis* is presented. We suggest that *N. propinqua* is a vicariant species that was isolated from a population contiguous with that in western Europe with the opening of the Atlantic Ocean.

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Key words. – Nabidae, sexual dimorphism, wing dimorphism, biogeography, phylogeny.

INTRODUCTION

Nabicula (Limnonabis) propinqua (Reuter), recognized by its large size and elongate, slender form, is one of the most conspicuous North American species of Nabidae (fig. 1). Unlike some of the commonly encountered species of *Nabis* that occur on vegetation in a variety of habitats, *N. propinqua* is rare in collections and lives on the ground or low vegetation in marshy habitats (Blatchley 1926). In addition to *N. propinqua*, five other species in the genus *Nabicula* Kirby occur in North America (Henry & Lattin 1988). *N. propinqua*, however, is the only member of the subgenus *Limnonabis* Kerzhner in North America, the other five species occur in Europe and Eastern Asia.

The most recent nomenclature (Kerzhner 1988) considers *Nabicula* a subgenus of *Nabis*, and does not recognize *Limnonabis* as a taxonomic group. In this paper, however, we use the nomenclature of Kerzhner (1981) because this classification has also been used in recent faunistic works for Europe (Péricart 1987) and North America (Henry & Lattin 1988). In addition, species relationships within *Nabicula* are still unresolved and we anticipate the nomenclature of Kerzhner (1988) to change again (unpublished data).

Reuter (1872) described *N. propinqua* in *Nabis* Latreille from a single brachypterous female specimen from Wisconsin, and described *vicarius* (in *Nabis*) from a single brachypterous male from Illinois. Reuter (1880) synonymized *vicarius* with *propinqua*. Hart (1907) described *elongatus* (in *Nabis*) from a single macropterous male from Havana, Illinois. This species was synonymized with *propinqua* by Van Duzee (1916).

In this paper, we summarize the distribution and habits of *N. propinqua* and describe the internal genitalia for both the male and female. We also present a cladistic analysis of the subgenus *Limnonabis* and provide a hypothesis of the biogeographic history of the taxon.

DESCRIPTIVE PART

Distribution

Nabicula propinqua occurs along the eastern seaboard from Maryland to Maine and extends westward between 40° and 50° degrees N latitude throughout the Great Lakes region to North Dakota (fig. 2). West of the 100th meridian, *N. propinqua* occurs much farther north, with records

from Alberta, Manitoba, Quebec and above 60 degrees N latitude along Great Slave Lake in the Northwest Territory. Essentially the distribution of *N. propinquua* follows the Saline Lakes and Forest Zone of Freshwater Lakes limnological regions of Northgate & Larkin (1966). There are at least two populations of *N. propinquua* that are disjunct from the main distribution. We have collected *N. propinquua* from two localities in the coastal marshes in Oregon and have examined a single specimen from Meade Co., Kansas.

With the exception of the latter three records, most of the known distribution of *N. propinquua* occurs within the area occupied by the ice sheet of the Wisconsin Glaciation. If *N. propinquua* was present in North America during the Pleistocene, as we will argue, it must have been restricted to areas south of the ice sheet or in one of the far northern refugia (Matthews 1979). Because *N. pro-*

pinqua is not yet known to occur in the areas of northern glacial refugia, it seems likely that *N. propinquua* moved into the areas it now occupies from areas south of the Wisconsin ice sheet sometime within the last 10,000 years. In this scenario, the Kansas specimen probably represents a Pleistocene relictual population in an area previously occupied by *N. propinquua*. Other such populations are likely to be located (e.g. the marshes in the Sand Hills of western Nebraska).

The origin of the Oregon coast population is more perplexing. *N. propinquua* has not yet been found in the arid Inter-mountain region, nor in the mesic Willamette Valley and Puget Trough areas of Oregon and Washington. It appears to be restricted to the coastal marshes of Oregon and possibly Washington. Lattin (1966) suggested that this population might be an introduction from the eastern United States. Now, however, we believe this unlikely, considering the restricted habitat of this species and the fact that the Oregon population displays a slightly different genitalic structure than eastern populations (see below).

If *N. propinquua* or its direct ancestor was present in North America by the Eocene as we hypothesize (see Discussion), there were few barriers to impede East-West movement and a contiguous distribution across the northern latitudes would have been possible. Beginning in the Miocene, orogenic activity in western North America resulted in topographical geographic barriers and, perhaps more importantly, increased aridity in the Intermountain region. Because *N. propinquua* lives in moist, riparian habitats, this dramatic change in climate and terrain would have restricted mobility and could have led to the extinction of many, or all of the intervening populations.

This is merely a hypothesis of course, and we cannot actually date the separation of the west coast population and it is possible that it is a much more recent event. The climate of the northern United States during the Pleistocene periods was much more mesic than the present, with abundant, large shallow lakes and marshes throughout the Great Basin province (Smith 1978). This would have provided abundant habitats for *N. propinquua* from the Rocky Mountains west. With the advent of the Hypsithermal and higher temperatures, these habitats in this area largely disappeared (Barnosky et al. 1987), which could have left the coastal population isolated from those north and east of the Rockies. This hypothesis would be corroborated if relictual populations of *N. propinquua* were found in isolated marshes in the northern Great Basin.

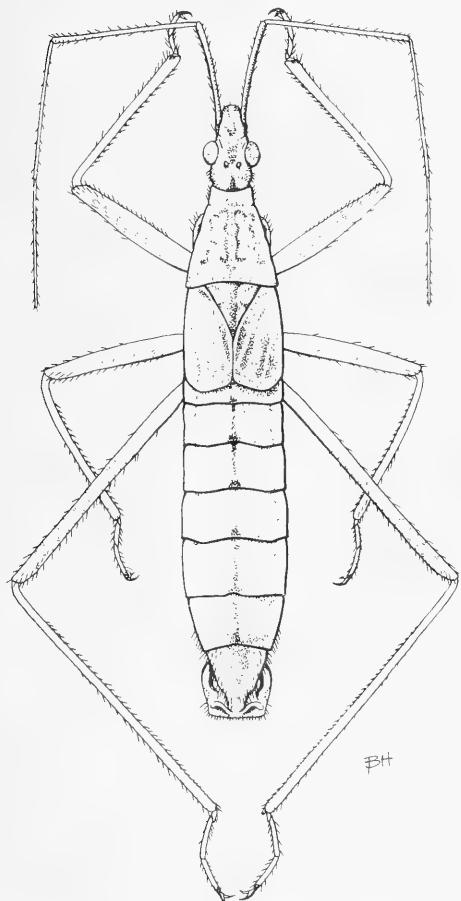


Fig. 1. *Nabidula propinquua* (Reuter). Brachypterus male. Dorsal habitus.

Dimorphism

In many nabids, males and females often differ markedly in size, occurrence of wings and propor-

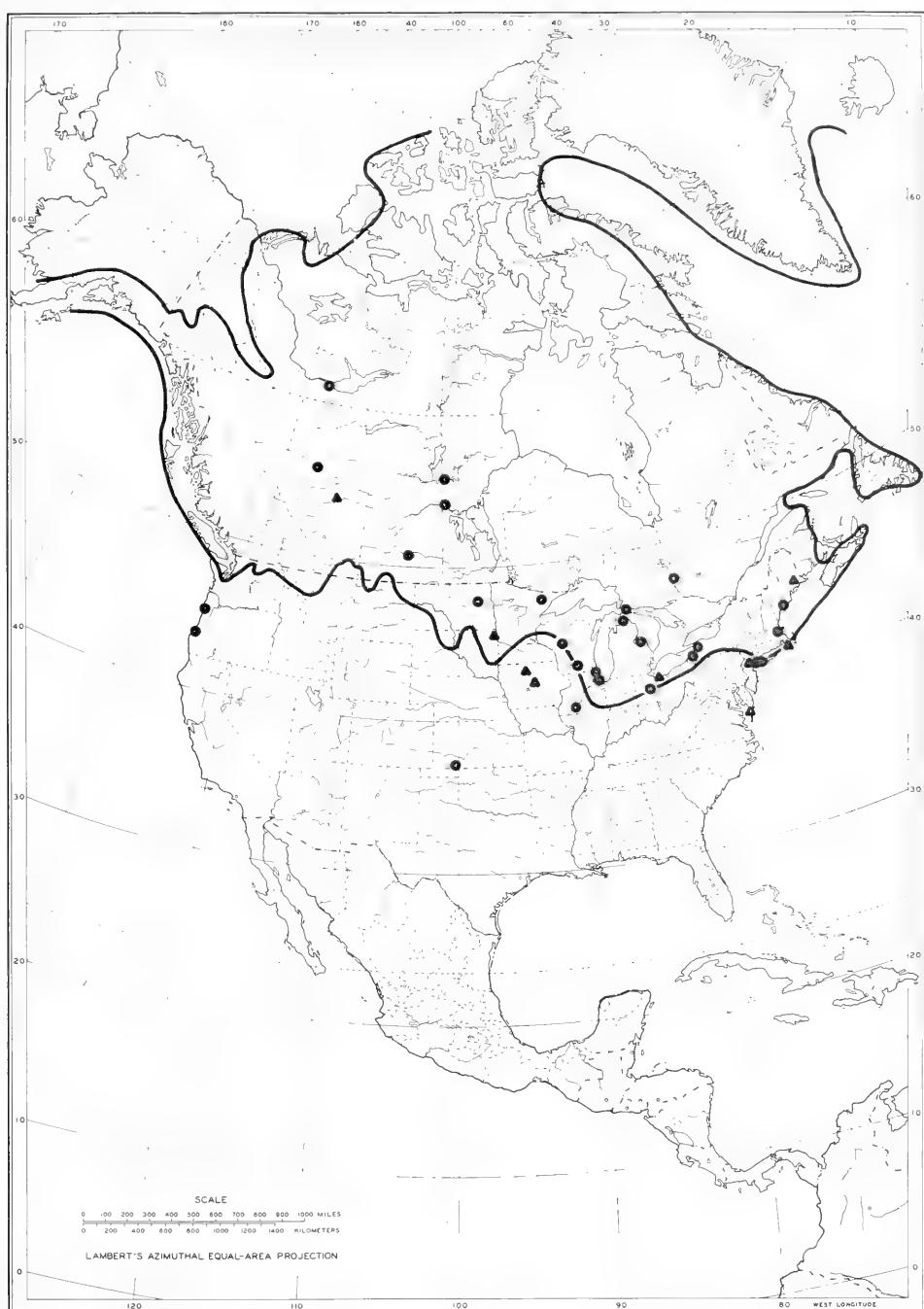


Fig. 2. Distribution of *N. propinqua* in North America. Circles represent specimens examined, triangles are literature records only. Solid line indicates maximum extent of Wisconsin ice sheet.

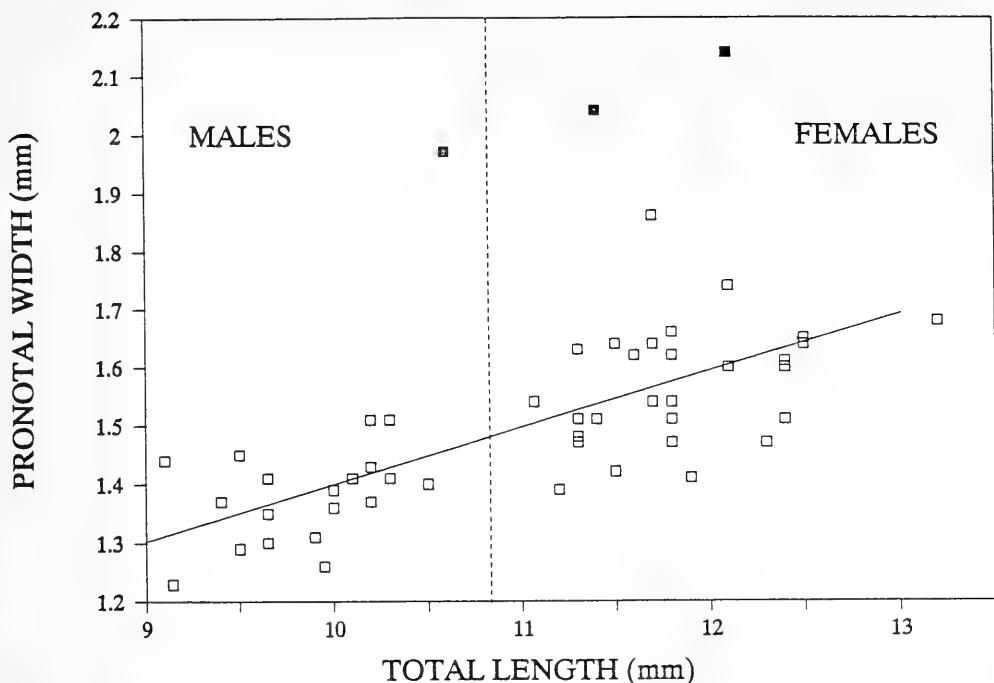


Fig. 3. Relationship between the posterior width of the pronotum and total length in *N. propinqua*. $y = 0.093239(x) + 0.465369$, $r^2 = 0.565$. Open squares are brachypterous specimens. Solid squares are macropterous specimens.

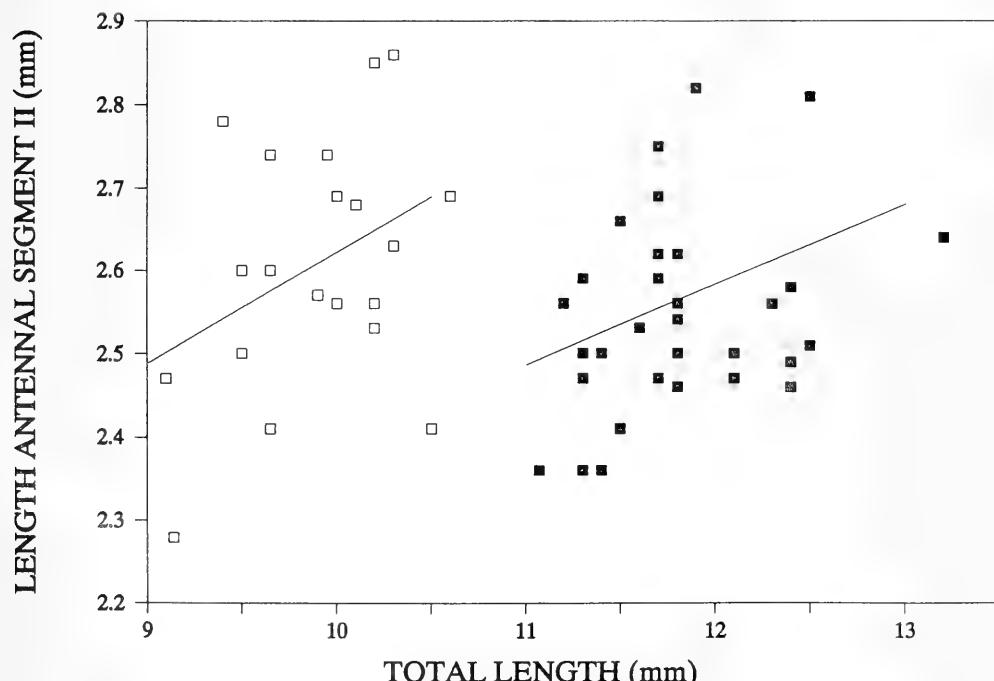


Fig. 4. Relationship between the length of the second antennal segment and total length in *N. propinqua*. Open squares are males. $y = 0.13069(x) + 1.318405$, $r^2 = 0.149$. Solid squares are females. $y = 0.077957(x) + 1.62609$, $r^2 = 0.101$.

Table 1. Comparison of six measurements among brachypterous and macropterous male and female *Nabicula propinqua*. Data are mean and (range) in mm.

	TL	VERT	PPW	PL	A1	A2
male	9.8 (9.1-10.6)	0.405 (0.38-0.44)	1.39 (1.23-1.51)	1.53 (1.41-1.69)	1.66 (1.51-1.85)	2.60 (2.28-2.86)
Brach M	10.5	0.41	1.97	1.69	1.70	2.69
female	11.8 (11.0-13.2)	0.444 (0.39-0.48)	1.57 (1.39-1.86)	1.73 (1.61-1.86)	1.65 (1.53-1.85)	2.55 (2.36-2.82)
Brach F	11.8 (10.3-12.1)	0.41 (0.40-0.42)	2.09 (2.04-2.14)	1.86 (1.83-1.89)	1.60 (1.59-1.60)	2.49 (2.48-2.50)

tions of body parts, but rarely are these differences quantified. We examined sexual dimorphism in six measurements, total length (TL), length of antennal segment one (A1), length of antennal segment two (A2), width of the vertex (VERT), posterior pronotal width (PPW) and pronotal length (PL). Measurements using an ocular micrometer were made of 21 males and 32 females from throughout the range of *N. propinqua*. We found differences between sexes in four of the six measurements. TL, VERT, PPW and PL, were greater in females than in males, but there were no differences between males and females for A1 and A2 (table 1). The differences between sexes seen in the former characters are explained by the positive linear relationship between these characters and the absolute size of the individual. For example, PPW increases with TL, and because females achieve a greater TL than males, they also display a greater PPW (fig. 3). We do not consider these characters true sexual dimorphisms therefore, but only size dependent characters.

The lengths of antennal segments also displayed an increase with TL, but only within a given sex. This is demonstrated by the fact that the slopes of the A2-TL regressions for the two sexes are the same ($F = 0.415$, $P = 0.523$), but the Y intercepts are different ($F = 8.662$, $P = 0.005$) (fig. 4). This indicates that although females are larger than males (greater TL), small males have the same length antennae as small females and large males have the same length antennae as large females.

Thus, in males, the antennae are disproportionately longer than in females. The length of the antennae seems to be uncoupled from the general correlation with body size that other measurements show. This relationship does not appear to be common in the Nabidae. In a preliminary analysis of four species of *Nabis*, males did not have disproportionately longer antennae, but rather there was a linear relationship between antennal length and size across the sexes.

Macroptery

Nabicula propinqua usually occurs in the brachypterous state, with the apex of the fore wings

reaching to the middle of the second abdominal tergite (fig. 1). Macropterous females have been reported by Harris (1928) and Froeschner (1971). Only 2 of 45 females we examined were macropterous. In these individuals, the fore wings reached the middle of the seventh abdominal tergite. The hind wings are equally well developed, reaching to the anterior margin of the seventh abdominal tergite (fig. 5a).

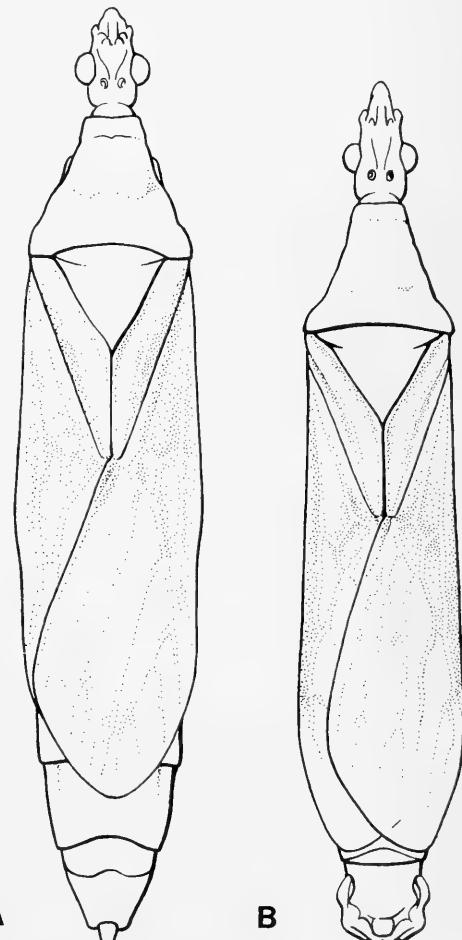


Fig. 5. *N. propinqua* A. Macropterous female. B. Macropterous male.

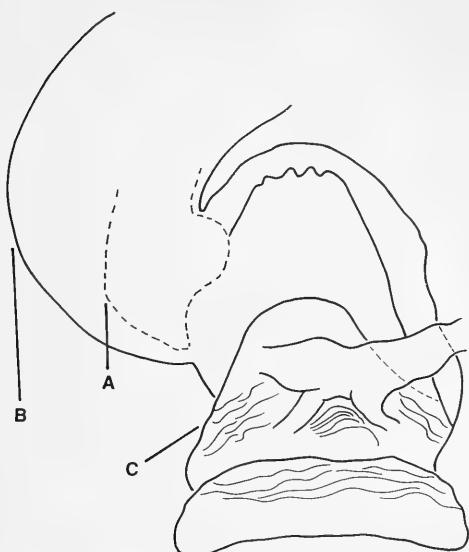


Fig. 6. Seminal depository of female *N. propinqua*. Dorsal view. A. Sclerotized ring. B. Membranous sac. C. Muscular lobe ventral to oviducts.

We have examined 29 male specimens and have seen only one macropterous individual (fig. 5b). This specimen was the holotype of *Nabis elongatus* Hart and is deposited in the Illinois Natural History Survey collection (INHS). Although Harris examined the material in the INHS (we have seen specimens with his determinations), he apparently overlooked this specimen, because he stated (Harris 1928) that males may never occur in the macropterous state. In England and on the Continent, only the females of *Nabicula lineata* (Dahlbom) are known in the macropterous form (Southwood and Leston 1959). Macropterous females and males have been reported for *N. ussuriensis* (Kerzhner) in eastern Asia (Kerzhner 1968).

Differences in the structure of the pronotum between brachypterous and macropterous specimens have been reported for both the latter two species. In *N. lineata*, the pronota of brachypterous specimens are 1.1 times as long as wide and in the macropterous forms the length and width are equal (Péricart 1987). In *N. ussuriensis*, the pronotum in brachypterous specimens is 1.1-1.2 times as long as wide and only 0.94 times as long as wide in macropterous specimens (Kerzhner 1968).

In *N. propinqua*, the ratio of PL to PPW is lower in the macropterous form (0.85-0.89) than the brachypterous form (1.05-1.15) in both males and females. The lower ratio results not from a shortening of the pronotum in the macropterous form, but from an increase in the width (fig. 3). In particular, the posterior lobe of the pronotum is greatly flared.

The increased width of the pronotum is probably an indirect effect of the development of flight muscles and phragmata in the pterothorax of the winged form (Darnhoffer-Demar 1969). Because the anterior end of the mesothorax is enclosed by the posterolateral angles of the pronotum, an increase in diameter of the mesothorax would cause a similar change in the posterior lobe of the pronotum.

Female Genitalia

The seminal depository is large and dome-shaped, consisting of a fleshy external portion and a partially sclerotized internal structure, the apex of which bears three to five blunt sclerotized teeth (fig. 6). A thick muscular structure lies between the base of the depository and the oviduct. The sclerotized ring is a single structure occupying the ventral surface of the left side of the depository, extending from the depository laterally and curving anteriorly. It is surrounded by a large membrane also directed anteriorly.

Male Genitalia

Parameres

Reuter (1872) and Harris (1928) provided lateral views of the left paramere of *Nabicula propinqua*. Paramere morphology in some groups of Nabidae is very conservative (e.g. the genus *Nabis*) and *N. propinqua* displays this general form (fig. 7). Within the subgenus *Limnonabis*, the paramere of *N. propinqua* most closely resembles that of *N. pontica*. In contrast, *N. lineata* displays an unusually elongate apex. In some specimens of *N. propinqua*, the apex of the paramere is slightly bent laterally, a condition which is strongly developed in *N. ussuriensis* (Kerzhner) and *N. demisa* (Kerzhner 1968, 1981).

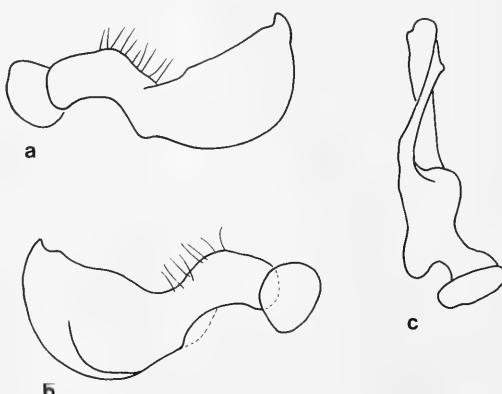


Fig. 7. Right paramere of *N. propinqua*. A. Lateral view. B. Medial view. C. Ventral view.

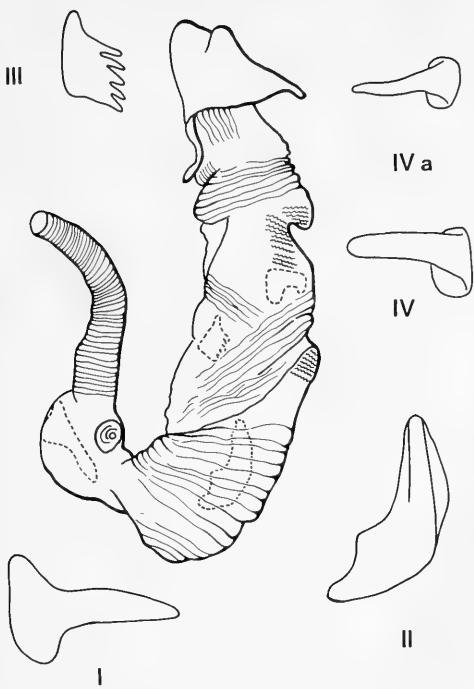


Fig. 8. Male aedeagus of *N. propinqua* from Oregon. Sclerites indicated by roman numerals. IVa. sclerite IV of specimen from Illinois.

Aedeagus

The aedeagus of *Nabicula propinqua* is very similar to that of *N. lineata* and *N. pontica*. The membranous portion of the aedeagus has four sclerites (fig. 8). No nomenclature has been proposed for the aedeagal sclerites of the Nabidae, and here we number the sclerites with Roman numerals beginning at the base of the aedeagus (sclerite I) and moving to the apex (sclerite IV). Sclerite I is linear and parallel to the longitudinal axis of aedeagus; it has a wide base and slightly tapering distal arm with a blunt, rounded apex. Some specimens may display a slight flange on this sclerite. Sclerite II is pistol-shaped, with a wide, arcuate base, a curved obtuse angle near its midpoint and a tapering, rounded distal arm. The distal arm bears flanges on both edges reaching from angle to apex. Sclerite III is roughly quadrangular and distinctly comb-shaped, with five short, blunt teeth directed toward the midline of the aedeagus. Sclerite IV is situated transversely in the aedeagus, with a broad, oval base. This sclerite exhibits geographic variation. In specimens from the Oregon coast, the sclerite has a thick, bluntly rounded arm (fig. 8 IV), and in specimens from east of the Rocky Mountains, the arm is longer, thinner, with a more pointed apex. (Fig. 8 IVa). There are two areas with sclerotized

denticles along the folds of the membrane, one area distal to sclerite II and the other distal to sclerite IV. These denticulate areas are also present in identical form in related species.

PHYLOGENETIC ANALYSIS

To understand the origin and evolution of *Nabicula propinqua* in North America, it is necessary to identify its phylogenetic relationship to other taxa. Within *Nabicula*, Kerzhner (1981) recognized three subgenera, *Limnonabis* Kerzhner, *Dolichonabis* Reuter, and *Nabicula* Kirby. He distinguished the subgenus *Limnonabis* from *Dolichonabis* (*sensu strictu*) by the diverging posterior lobe of the head, recurved connexivum of the male and the presence of three or four sclerites in the aedeagus. Within *Limnonabis*, he identified two groups, the *lineata* group composed of *N. lineata*, *N. pontica* and *N. propinqua*, identified by the large parameres and multiple rows of spines of Ekblom's organ (see fig. 11). The *ussuriensis* group contains *N. ussuricensis* (Kerzhner), *N. demissa* (Kerzhner) and *N. sauteri* (Poppius), united by the small parameres and the single row of spines (see fig. 10).

To further clarify the relationships among these taxa, we conducted a cladistic analysis of the subgenus *Limnonabis* using the computer program HENNIG 86 (Farris 1988). Because we were not able to examine specimens of all species in the subgenus, we used characters that were described and/or illustrated for the other taxa by Kerzhner (1968, 1981) and Péricart (1987). We used structures of the male

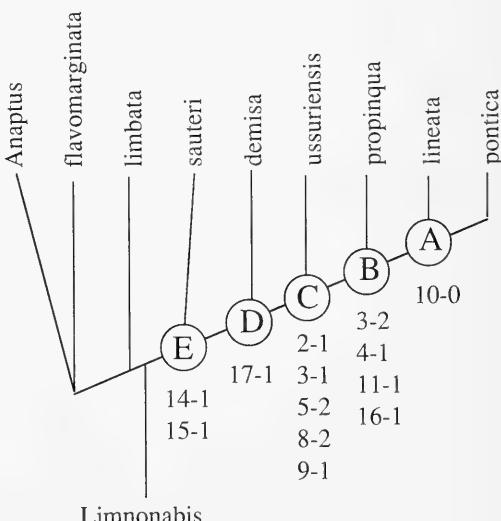


Fig. 9. Cladogram of *Limnonabis* species based on table 2. Nodes denoted by letters in circles. Characters and character states of synapomorphies given under each node.



10



11



12



13

Figs. 10-11. Posterior view of male genital capsule showing Ekblom's organ. 10. *N. americolimbata*, single row of spines. 11. *N. propinqua*, multiple rows of spines.
Figs. 12-13. Structure of individual spines of Ekblom's organ. 12. *N. americolimbata*. 13. *N. propinqua*.

Table 2. Description of characters used in the cladistic analysis of the subgenus *Limnonabis*. Character states are preceded by their coding in the data matrix and (in parentheses) the number of times state arises in the cladogram.

Female Genitalia

1. 0(1) Double sclerotized ring.
1(1) Single sclerotized rings.
2. 0(1) Sclerotized ring symmetric, located mediodorsal.
1(1) Sclerotized ring asymmetric, located laterally.
3. 0(1) Membranous "sac" around sclerotized ring absent.
1(1) Membranous "sac" symmetric, located dorsally.
2(1) Membranous "sac" asymmetric, not located dorsally.
4. 0(1) Muscular "lobe" antero-ventral to sperm ducts absent.
1(1) Muscular "lobe" antero-ventral to sperm ducts present.

Male Aedeagus

5. 0(1) Aedeagus with fewer than three sclerites.
1(1) Aedeagus with 3 sclerites.
2(1) Aedeagus with 4 sclerites.
3(1) Aedeagus with more than 4 sclerites.
6. 0(1) Length of sclerite I less than four times its width at middle.
1(1) Length of sclerite I at least four times its width.
7. 0(2) Sclerite I without flanges present.
1(1) Sclerite I with flanges.
2(1) Sclerite I with flanges only slightly developed.
8. 0(1) Sclerite II absent.
1(1) Length of sclerite II less than three times its width.
2(1) Length of sclerite II three times its width.

9. 0(1) Sclerite II without flanges.
1(1) Sclerite II with flanges.
10. 0(1) Sclerite III linear without flanges.
1(1) Sclerite III prong-shaped.
2(1) Sclerite III comb-shaped.
3(1) Sclerite III short, not linear.
4(1) Sclerite III linear with flanges.
11. 0(1) Sclerite IV absent.
1(1) Sclerite IV with recurved arm.
2(1) Sclerite IV comb-shaped.

Male Paramere

12. 0(1) Tip of paramere not elongate.
1(2) Tip of paramere elongate.
13. 0(1) Apex of paramere straight.
1(2) Apex of paramere bent laterally.

External Structure and Form

14. 0(1) Head straight or converging behind eyes.
1(1) Head diverging behind eyes.
15. 0(1) Medial half of male connexivum straight.
1(1) Medial half of male connexivum curved under and appressed to abdomen.
16. 0(1) Spines of Ekblom's organ in a single linear row.
1(1) Spines of Ekblom's organ in a bunched row.
17. 0(1) Body length less than 5 times the width.
1(1) Body length greater than 5 times the width.

paramere (2 characters), aedeagus (6 characters), male genital capsule (1 character), female genitalia (3 characters), body structure (4 characters) (table 2). Determining the polarity of some of the characters was difficult, because the homology of some of the structures in other genera could not be determined and no previous cladistic analysis within the Nabidae was available for comparison. Because of these problems, we included the following three taxa in our analysis as outgroups, *Nabicula (Dolichonabis) limbata* (Dahlbom); *Nabicula (Nabicula) flavomarginata* (Scholtz); *Anaptus major* (A. Costa) (table 3). These taxa were chosen because they represent the other two subgenera of *Nabicula* and a more distant member of the tribe Nabini. All multistate characters were coded as ordered except characters 5 and 10 because we were uncertain of their transformation sequences.

The analysis produced a single tree of minimal length (31 steps, consistency index of 83.0, fig. 9). The subgenus *Limnonabis* appears to be a monophyletic group, as indicated by component E of the cladogram. It is identified by characters 14 and 15, the diverging posterior margin of the head, and the recurved connexivum of the male respectively.

These are two of the characters Kerzhner (1968) used to define the subgenus. We are doubtful of the integrity of the first character, the diverging posterior lobe of the head. We have examined species in other genera (*Nabis* Latreille, *Lasiomerus* Reuter) in which this character displays almost the same development as seen in *Limnonabis*. At this time, we can find no genitalic characters that unite all species currently placed in *Limnonabis* and the only character that we feel defines the group is the recurved connexivum of the male.

The *ussuriensis* group does not appear to be a natural one, its members are united only by plesiomorphic characters, such as the single row of spines of Ekblom's organ. *Nabicula ussuriensis* is actually united with the *lineata* group by the presence of an asymmetric sclerotized ring (2-1) (character-character state), presence of a membranous "sac" around sclerotized ring (3), aedeagus with four sclerites (5-2), length of sclerite II three times its width (8-2) and sclerite II with flanges (9-1) (component C). The *lineata* group of Kerzhner (1968) is clearly monophyletic, represented by component B on the cladogram and defined by the asymmetric membranous sac (3-2), muscular lobe

Table 3. Character matrix for *Limnonabis* processed by HENNIG86.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Anapitus</i>	1	0	0	0	3	0	0	?	0	?	?	1	0	0	0	0	0
<i>flavomarginata</i>	0	0	0	0	0	1	0	?	?	?	0	1	0	0	0	0	0
<i>limbata</i>	1	0	0	0	0	1	1	?	?	?	0	1	0	0	0	0	0
<i>sauteri</i>	1	0	0	?	1	1	1	0	0	3	0	0	0	1	1	0	0
<i>demisa</i>	1	0	0	0	1	0	0	1	0	1	0	0	1	1	1	0	1
<i>ussuriensis</i>	1	1	1	0	2	1	1	2	1	4	2	0	1	1	1	0	1
<i>propinqua</i>	1	1	2	1	2	1	2	2	1	2	1	0	0	1	1	1	1
<i>lineata</i>	1	1	2	1	2	1	0	2	1	0	1	1	0	1	1	1	1
<i>pontica</i>	1	1	2	1	2	1	0	2	1	0	1	0	0	1	1	1	1

behind the sperm ducts (4-1), and the bunched row of spines comprising the Ekblom's organ (16-1). The latter character appears to be unique among the Nabidae. *Nabicula propinqua*, *N. lineata*, and *N. pontica* display a bunched row, 3-5 spines wide, on each side of the anal tube (fig. 11). All other species of nabids that we have examined possess only a single row of linearly arranged spines (fig. 10). The structure of the individual spines may also prove to be an informative character. In *N. propinqua*, the spines are thin, with the distal third sharply narrowed, sinuous, with the apex curved laterally (fig. 13), while in *N. (Limnonabis) americolimbata*

the spines are wider, with the distal halves flattened and expanded (fig. 12).

Nabicula lineata and *N. pontica* are united by having sclerite III linear and without flanges (10-0) and sclerite I without flanges (7-0). This latter character is homoplasious, because the 0 state also appears in *N. demisa*.

BIOGEOGRAPHY

All members of the subgenus *Limnonabis*, with the exception of *Nabicula propinqua*, are found in the Palaearctic region. The three species arising

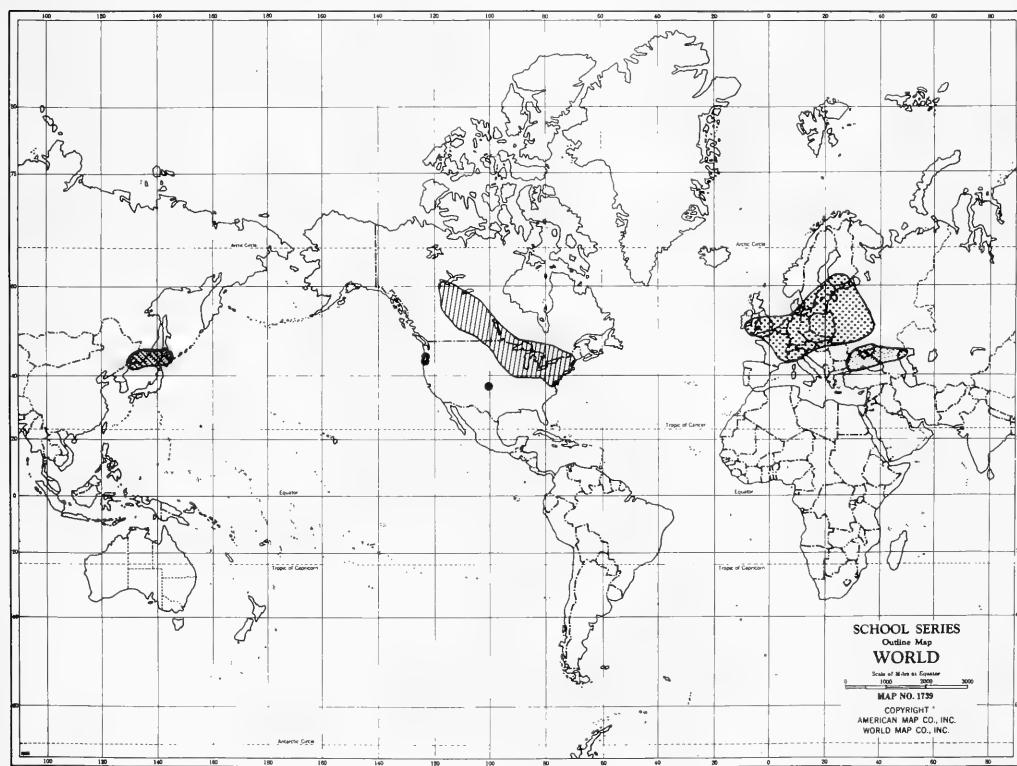


Fig. 14. Distribution of the subgenus *Limnonabis*. Vertical lines and solid circles in North America, *N. propinqua*. Large dots in Europe, *N. lineata*. Small dots in southeastern Europe, *N. pontica*. Slanted lines with small dots in southeast Asia, composite ranges of *N. ussuriensis*, *N. demisa* and *N. sauteri*.

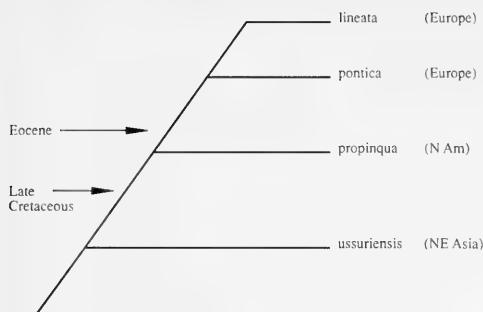


Fig. 15. Cladogram of *Limnonabis* with the present distribution indicated after each species name. Hypothesized ages of intercontinental vicariances indicated at left.

from the cladogram first, *N. ussuriensis*, *N. demisa* and *N. sauteri* occur in far eastern Asia (fig. 14). Two members of the *lineata* group, *N. lineata* and *N. pontica* occur in Europe and the Mediterranean region and *N. propinqua* occurs only in North America. With regard to the views of Ball (1975), we generated a testable biogeographic hypothesis to explain the present distribution of the members of the monophyletic group represented by component C on the cladogram. We chose to use only this group and not all of *Limnonabis*, because *N. sauteri* and *N. demisa* are primitive taxa whose placement in the subgenus appears tenuous.

We hypothesize that the distributions of the species in component C are the result of vicariance caused by the breakup of Laurasia beginning in the Cretaceous. With the development of the Turgai straits in the late Cretaceous, Asiamerica and Euramerica were separated into two distinct land masses (Cox 1974). This would have resulted in the ancestral population being divided into two groups, with the ancestor of *N. ussuriensis* in western Asiamerica and the ancestors of the *lineata* group in Euramerica.

The ancestor of the *lineata* group was distributed throughout Euramerica and with the opening of the North Atlantic eventually separating North America from Europe in the Eocene, the ancestor of *N. propinqua* was isolated from that of *N. lineata* and *N. pontica*. The exact time of separation of these two groups cannot be known because there were several distinct land bridges that closed at different times, with at least one dispersal route across the Thulean bridge which may have persisted into the Miocene 20 millions years ago (Noonan 1988). With the exception of the elongate apex of the paramere in *N. lineata*, *N. lineata* and *N. pontica* are very similar, suggesting that the separation of these two species is a more recent event.

In summary, we invoke two vicariant events to

explain the origin and present distribution of the taxa in component C of the cladogram (fig. 15). 1) The ancestor of *N. ussuriensis* was isolated in Asiamerica from component B in Euramerica by the Turgai Straits. 2) The ancestor of *N. propinqua* was isolated from component A in Europe by the opening of the Atlantic. If our phylogenetic hypothesis is correct, we believe this biogeographic scenario to be the most parsimonious one. A dispersal hypothesis for the evolution of component C would require the ancestral form to have moved into, and then gone extinct from an area reaching from Eastern Europe to Eastern Asia. Likewise, dispersal of the ancestor of *N. propinqua* from Europe to North America via Beringia as suggested by Schaefer & Calabrese (1980), would require the extinction of this taxon in all of northern Asia. Another hypothesis for *propinqua* reaching North America is by dispersal across the North Atlantic. Because of the specialized habits, low incidence of macroptery and low vagility of this species (it has not been recorded from flight traps or aerial sampling), we consider the latter hypothesis unlikely.

DISCUSSION

Using examples from the Trichoptera, Homoptera and Coleoptera, Allen (1983) discussed the North America – Europe – Northeast Asia distributions for insects. He found a common pattern among these groups in which the North American and European taxa shared a common ancestor after the origin of the Northeast Asian groups. Similar to our hypothesis for *Limnonabis*, Platnick (1976) discussed the vicariant patterns in the spider genus *Callilepis* (Gnaphosidae). His phylogenetic analysis of the genus showed that species groups were distributed in areas that reflected the breakup of Laurasia. He also suggested that the Turgai straits separated a Asiamerica group from a Euramerica one, and the Atlantic rift further separated the Euramerica group.

The species in the *N. lineata* group are very similar morphologically, differing primarily in the structure of the internal genitalia. It may seem unusual that we invoke such great ages for the separation of these species in light of the slight degree of morphological divergence. Without rehashing the old and continuing debate regarding rates of evolution, we feel that our hypothesis is tenable for three reasons. First, with few exceptions (e.g. *Nabicula subcoleoptrata* Kirby) the lineages within the tribe Nabini appear to be highly conservative or canalized in their morphology. Many species differ only slightly in external morphology and are distinguished primarily by the male aedeagus and the seminal depository of the female.

Second, explosive speciation and morphological evolution is often correlated with changing envi-

ronments or lineages radiating into new adaptive landscapes (Simpson 1944), while groups occupying stable, constant and predictable environments may undergo very little change through time. The *lineata* group inhabits moist, marshy habitats and secondarily, estuarine marshes, environments that prevailed during the Cenozoic but also have persisted relatively unchanged to the present. Considering the stability of morphology in the group, low vagility and their specific, unchanged habitat, large scale vicariant events resulting in superficially similar, disjunct species might be expected.

Finally, it is becoming increasingly apparent that in some groups of insects, extant species are of great antiquity. In the Coleoptera for example, the Pleistocene climatic oscillations greatly altered distributions but did not result in speciation (Coope 1970, Matthews 1977). Some species of beetles are apparently in excess of 10 million years old (Larsson 1978). Similar examples are available for the Heteroptera, (Calabrese 1978, 1980).

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REFERENCES

Allen, R. T., 1983. Distribution patterns among arthropods of the North Temperate Deciduous Forest biome. – Annals of the Missouri Botanical Garden 70: 616-628.

Ball, I. R., 1975. Nature and formulation of biogeographical hypotheses. – Systematic Zoology 24: 407-430.

Barnosky, C. W., P.M. Anderson & P.J. Bartlein, 1987. The northwestern U.S. during deglaciation: vegetational history and paleoclimatic implications. – In: W.F. Ruddiman and H.E. Wright (eds.). North America and adjacent oceans during the last glaciation. – Geological Society of America, K-3: 289-321.

Blatchley, W. S., 1926. Heteroptera or true bugs of Eastern North America, with especial reference to the faunas of Indiana and Florida. – Nature Publishing Company, Indianapolis. 1116 pp.

Calabrese, D. M., 1978. Identity of *Gerris* (Hemiptera: Heteroptera) species from Pleistocene asphalt deposits at McKittrick, California. – Entomological News 89: 59-60.

Calabrese, D. M., 1980. The zoogeography and a cladistic analysis of the Gerridae (Hemiptera: Heteroptera). – Miscellaneous Publications of the Entomological Society of America 11: 1-119.

Coope, G. R., 1970. Interpretation of Quaternary insect fossils. – Annual Review of Entomology 15: 97-120.

Cox, C. C., 1974. Vertebrate paleodistribution patterns and continental drift. – Journal of Biogeography 1: 75-94.

Darhoffer-Demar, B., 1969. Zur Funktionsmorphologie der asserläufer. I. Die Morphologie des Lokomotionsapparates von *Gerris lacustris* L. (Heteroptera: Gerridae). – Zoologische Jahrbücher Abteilung für Anatomie und Ontogenie der Tiere 86: 28-66.

Farris, J. S., 1988. Hennig86 reference. Documentation for version 1.5. – Stoney Brook, New York.

Froeschner, R. C., 1971. *Nabis propinquus* Reuter ranges southward into Maryland. (Hemiptera: Nabidae). – Proceedings of the Entomological Society of Washington 73: 268.

Harris, H. M., 1928. A monographic study of the Hemipterous family Nabidae as it occurs in North America. – Entomologica Americana 9: 1-98.

Harris, H. M., 1943. Additions to the South Dakota list of Hemiptera. – Journal of the Kansas Entomological Society 16: 150-153.

Hart, C. A., 1907. Zoological studies in the sand regions of the Illinois and Mississippi River Valleys. – In: Hart, C.A. & H.A. Gleason (eds.), On the biology of the sand areas of Illinois. – Bulletin of the Illinois State Laboratory of Natural History 7: 137-272.

Hendrickson, G. O., 1930. Studies on the Insect fauna of Iowa prairies. – Iowa State College Journal of Science 4: 49-179.

Henry, T. J. & J. D. Lattin, 1988. Family Nabidae. – In: T. J. Henry & R. C. Froeschner (eds.), Catalog of the Heteroptera or True Bugs, of Canada and the Continental United States. E.J. Brill, Leiden, New York, 958 pp.

Hussey, R. F., 1922a. On some Hemiptera from North Dakota. – Occasional Papers of the Museum of Zoology, University of Michigan 115: 1-23.

Hussey, R. F., 1922b. Hemiptera from Berrien County, Michigan. – Occasional Papers of the Museum of Zoology, University of Michigan. 118: 1-39.

Kerzhner, I. M., 1968. New and little known Palearctic bugs of the family Nabidae (Heteroptera). – Entomological Review 47: 848-863.

Kerzhner, I. M., 1981. Fauna SSSR. Nasekomye khobotnye, t. XIII, vyp. 2: Poluzhestkorylye semejstva Nabidae [Hemiptera of the family Nabidae]. – Leningrad, 326 pp.

Kerzhner, I. M., 1988. Family Nabidae. In: P.H. Ler (ed.). Keys to the identification of insects of the Soviet Far East. Vol 2: Homoptera and Heteroptera. Nauka. Leningrad.

Larsson, S. G., 1978. Baltic Amber – a palaeobiological study. – Entomonograph 1. Scandinavian Science Press Ltd., Klampenborg, Denmark. 192 pp.

Lattin, J. D., 1966. *Stalia major* (Costa) in North America

(Hemiptera: Nabidae). – Proceedings of the Entomological Society of Washington 68: 314-318.

Matthews, J. V. Jr., 1977. Tertiary Coleoptera fossils from the North American Arctic. – Coleopterist's Bulletin 31: 297-308.

Matthews, J. V. Jr., 1979. Tertiary and Quaternary environments: historical background for an analysis of the Canadian insect fauna. – In: H. V. Danks, (ed.), Canada and its insect Fauna. – Memoirs of the Entomological Society of Canada 108: 31-86.

Noonan, G. R., 1988. Faunal relationships between eastern North America and Europe as shown by insects. – In: J. A. Downes & D. H. Kavanaugh (eds.). Origins of the North American Insect Fauna. – Memoirs of the Entomological Society of Canada 144: 39-53.

Northgate, T. G. & P. A. Larkin, 1966. Western Canada. pp. 451-485. – In: D. G. Frey (Ed.). Limnology of North America. – University of Wisconsin Press. Milwaukee & London.

Péricart, J., 1987. Hemipteres Nabidae: d'Europe Occidentale et du Maghreb. – Faune de France 71: 1-185.

Platnick, N. I., 1976. Drifting spiders or continents? Vicariance biogeography of the spider subfamily Larioninae (Araneae, Gnaphosidae). – Systematic Zoology 27: 101-109.

Reuter, O. M., 1872. Nabidae novae et minus cognitae. Bidrag till Nabidernas kannedom. – Ofversigt af Kongliga Svenska Vetenskaps-Akademiens Förhändlingar 29(6): 79-96.

Reuter, O. M., 1880. Anteckningar om *Coriscus lineatus* Dahlb. – Ofversigt af Finska Vetenskaps-Societetens Förhändlingar 22: 25-32.

Schaefer, C. W. & D. M. Calabrese, 1980. Amphi-Atlantic species-pairs in two genera of water striders (Hemiptera, Gerridae). – Entomologia Generalis 6: 271-280.

Simpson, G. G., 1944. Tempo and Mode in Evolution. – Columbia University Press. New York. 237 pp.

Smith, G. R., 1978. Biogeography of Intermountain fishes. – In: K. T. Harper & J. L. Reveal (Eds.), Intermountain biogeography: A symposium. – Great Basin Naturalist Memoirs 2: 17-42.

Southwood, T. R. E. & D. Leston, 1959. Land and water bugs of the British Isles. – Frederick Warne and Co. Ltd., London and New York. 436 pp.

Strickland, E. H., 1953. An annotated list of the Hemiptera of Alberta. – Canadian Entomologist 85: 193-214.

Van Duzee, E. P., 1916. Check List of the Hemiptera (Excepting the Aphididae, Aleurodidae and Coccoidea) of America, North of Mexico. – New York Entomological Society, New York, 111 pp.

APPENDIX

Literature Records

Canada. -- Alberta: Edmonton (Strickland 1953). United States. -- Illinois: Cook Co.: Argo; West Pullman (Blatchley 1926). – Iowa: Hancock Co.: 8 mi. SE Britt, July 6, 1928 (Hendrickson 1930). – Maryland: Somerset Co.: Deal Island, June 29, 1970 (Froeschner 1970). – Michigan: Berrien Co.: New Buffalo & Stevensville (Hussey 1922b). – New Jersey: Morris Co.: Snake Hill; ?? Co.: White's Bay, July 20, 1914 (Froeschner 1971). – North Dakota: Ramsey Co.: Devils Lake, July 22 & 25 (Hussey 1922a). – South Dakota: Day Co.: Waubay, August 21, 1924 (Harris 1943); Grant Co.: Bigstone, August 20, 1924 (Harris 1943).

Specimens Examined

Canada. — Alberta: High Prairie, July 17, 1961, A. R. Brooks, 1 ♂, 1 ♀ (OSU); Slave Lake, August 14, 1924, O. Bryant, 2 ♂, 1 ♀ (CAS). – Manitoba: Red Deer R., August 3, 1937, C. L. Johnston, 1 ♂ (KU); The Pas, August 11, 1937, D. G. Denning, 1 ♀ (UM). – North West Territory: 5 mi. SE Ft. Providence, August 15, 1965, J. & W. Ivie, 1 ♀ (AMNH). – Ontario: Thessalon Lake, shore, July 21, 1965, J. & W. Ivie, 1 ♀ (AMNH). – Quebec: Quinze Lake, August 15, 1907, W. J. Palmer, 1 ♀ (CAS); Saskatchewan: Qu Appelle River, N Tuxford, July 29, 1965, J. & W. Ivie, 2 ♀ (AMNH).

United States. — Illinois: Boone Co.: Belvidere, June 27, 1955, J. A. Slater (OSU); Fulton Co.: Havana, June 9, 1905 / Ill. Sands, Hart Coll. / *Nabis elongatus* Hart, type / *Reduvius elongatus* Hart / TYPE *Nabis elongatus*, C. A. Hart, 1 ♂ (INHS); Lake Co.: Fox Lake, August 23, 1944, Frison & Ross, 4 ♂, 9 ♀ (INHS); Lake Villa, swamp, August 10, 1906 / *Reduvolius vicarius* Reuter, micr. F / *Nabis propinquus* Reuter, H. M. Harris / Van Duzee Cat. No. 825 Det. Harris, 1 ♀ (INHS); Waukegan, May 14, 1930 4 ♂ (INHS); Waukegan, beach, August 23, 1906 / *Reduvolius vicarius* Reut., Micro M / *Nabis propinquus* Reuter, Det. H. M. Harris / Van Duzee Cat. No. 825, Det. Harris 1 ♂, 1 nymph (INHS). – Kansas: Meade Co.: September 13, 1944, R. H. Beamer, 1 ♂ (OSU). – Maine: Sagadahoc Co.: Popham Beach, September 4, 1920, A. P. Morse, 1 ♀, (AMNH). – Massachusetts: Essex Co.: Beach Bluff, 22 June, 1914, H. M. Parshley, 1 nymph (CAS); 13 August, 1914, ex. *Carex*, 2 ♂, 4 ♀; June 21, 1915, 1 nymph (CAS); August 17, 1916, ex. *Carex*, 3 ♂, 11 ♀ (AMNH); Middlesex Co.: Faneuil, August 2, 1904, A. P. Morse, 1 ♂; August 12, 1904, A. P. Morse, 1 ♀; October 1, 1904, A. P. Morse, 1 ♀ (AMNH). – Michigan: Cheboygan Co.: July 25, 1940, L. Spencer, 1 ♀ (OSU); July 1, 1950 J. D. Lattin, 1 nymph (OSU); Duncan Bay, July 27, 1957, W. J. Hangan, 2 ♀ (KU); Emmet Co.: August 10, 1950, J. D. Lattin, 1 ♀ (OSU); Huron Co.: Sand Point, June 24, 1922, R. ♀. Hussey, 1 ♀ (FSCA). – Minnesota: Saint Louis Co.: Eaglesnest, July 15, 1959, W. V. Balduf, 2 ♂, 1 ♀ (UM); Traverse Co.: Lake Traverse, 7.5 mi SW Wheaton, July 27, 1974, B. Tollefson, 1 ♂, 1 ♀ (UCB). – New York: Cattaraugus Co.: South Dayton, 23 July, 1946, R. H. Beamer, 1 ♀ (KU); Erie Co.: Buffalo, July 16, 1901, 1 ♀ (CAS); Nassau Co.: Long Island, Cold Spring Harbor Biol. Lab., B. Darnall, 1 ♀ (CAS); Piermont, June 17, 1934, Scholt, 1 ♀ (AMNH). – North Dakota: Ramsey Co.: Devil's Lake, July 22, 1920, T. H. Hubbell, 1 ♂ (FSCA). – Ohio: Erie Co.: Cedar Point, Sandusky, August 31, 1905, Van Duzee, 1 ♀ (UCB); Union Co.??, Camp Perry, September 5, 1921, W. L. McAtee, 1 ♀ (USNM). – Oregon: Coos Co.:

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South Slough Sanctuary, SW Coos Bay, September 24, 1988, A. Asquith, 1 ♀ (OSU); Tillamook Co.: Island Camp, near woods, July 18, 1959, K. Fender, 1 ♂ (OSU); 5 mi E Pacific City, meadow, September 9, 1962, J. Capizzi, 2 ♀ (OSU); Sand Beach St. Pk., Sand Lake, September 7, 1988, A. Asquith & J. D. Lattin, 4 ♂, 12 ♀ (OSU). - Wisconsin: Dane Co.: T6N, RTE, S28, stream edge, aquatic net, September 14, 1973, J. Hender, 1 ♀ (UWIM); Wood Co.?, Nevin Marsh, July 23, 1974, site 6, sweep net, D. Bach, 1 ♂ (UWIM); July 11, 1974, site 2, D. Bach, 1 ♂ (UWIM).

NEW SPECIES OF *SUPERODONTELLA* STACH (COLLEMBOLA: ODONTELLIDAE) FROM THAILAND

Bedos, A. & L. Deharveng, 1990. New species of *Superodontella* Stach (Collembola: Odontellidae) from Thailand. – *Tijdschrift voor Entomologie* 133: 17-26, figs. 1-28, tabs. 1-3 [ISSN 0040-7496]. Published 31 July 1990.

The genus *Superodontella* Stach (Odontellidae) is recorded from Thailand for the first time. Four new species are described, *S. ciconia* sp. n., *S. gouzei* sp. n., *S. longispina* sp. n. and *S. flammata* sp. n. Some new morphological characters are presented.

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Key words. – Collembola, new species, Thailand.

INTRODUCTION

Superodontella was created by Stach in 1949 for the species *Odontella ewingi* Folsom, 1916. Long considered as a synonym of *Odontella* in the literature, it was redefined as a subgenus of *Odontella* by Deharveng (1981a). It differs from *Odontella* s. str. in the absence of an apical exsertile bulb on antennal segment IV. This character has proved to be consistent with biogeographical data, as no species of *Odontella* s. str. has been found outside the austral region in spite of extensive recent collecting in Madagascar, tropical America and South East Asia. Here we accept *Superodontella* as valid at generic level with the diagnosis given by Deharveng (1981a), because of the large number of species now known to have this antennal character.

TAXONOMIC CHARACTERS USED IN THE DESCRIPTIONS

The most important diagnostic characters for *Superodontella* occur in the antennal and buccal areas. Several new characters are introduced here.

Body length. — Adults are scarce, sometimes absent in many *Superodontella* species. 'Large juveniles' are specimens devoid of any sexual differentiation, but of a size as large as or larger than adults. The biological problem underlying these observations is under study.

Integument granulations. — (1) Shape, size and arrangement of secondary granules, particularly on head and abd. VI (abdominal segment VI). (2) Arrangement and morphology of muscular insertions on head (which could be studied on other areas of the body).

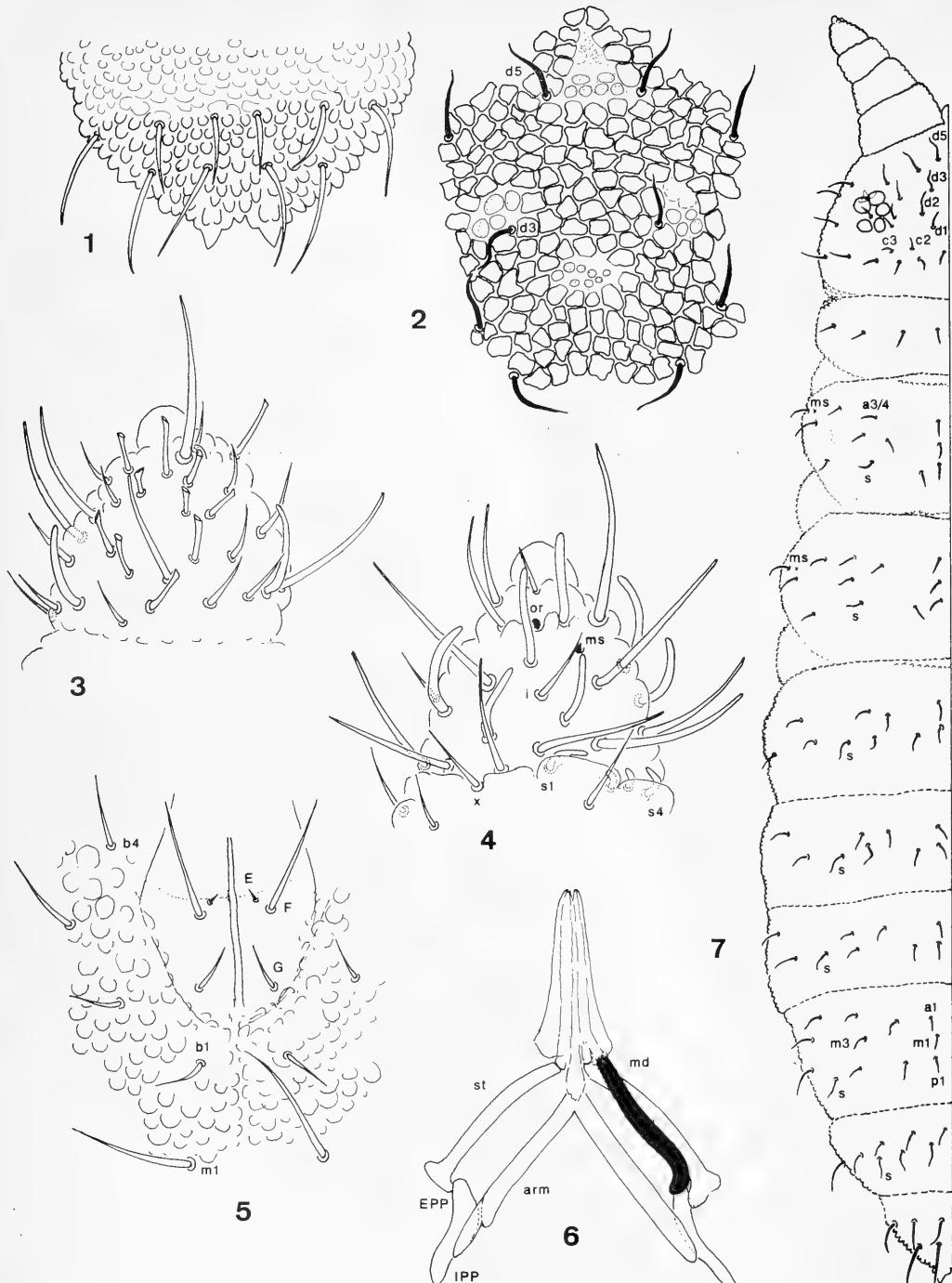
Antennae. — (1) Apical structures of ant. IV

(antennal segment IV). (2) Number and morphology of s-setae on ant. IV. (3) Number of trumpet-setae on ant. IV (mostly ventral; low intraspecific variability in adult, but character instar-dependent). (4) Form and length of s-setae on ant. III. (5) Number of ordinary setae on ant. III.

Ocular area. — (1) Morphology of PAO (postantennal organ) ('amiboid' with coalescence of lobes at base, or 'hypogastruroid' with well separated lobes). (2) Integument swellings between eyes.

Buccal area. — (1) Length and morphology of buccal cone (range from very short and thick to very long and thin). (2) Labrum chaetotaxy, difficult to observe, is usually not mentioned in descriptions. A conspicuous pair of longitudinal sclerotized structures terminating distally could be special modified setae; they are present in all studied species (fig. 12). (3) Labium chaetotaxy, following Massoud (1967) nomenclature (fig. 12). (4) Number and length of perilabial setae (following the nomenclature of Yosii (1971)) and postlabial setae (following in part the nomenclature of Da Gama (1988) (fig. 19). Both nomenclatures are incomplete when all Poduromorpha are considered; a general complete nomenclature is presently under study. (5) Form and length of maxilla stipa and fulcrum, including those of E.P.P. (external posterior processus) and I.P.P. (internal posterior processus), highly discriminant interspecific characters (fig. 6). (6) Number, form and length of mandibles.

Dorsal chaetotaxy. — (1) Morphology of ordinary setae, particularly on abd. VI. (2) Relative length of s-setae. (3) Position of s-setae on the tergites (stable in the species examined here). (4) Presence/absence of c2 seta on head. (5) Setae of central area (d- and sd-setae) are the same in all our



Figs. 1-7. *Superodontella ciconia* sp. n. — 1. Abdomen VI tergite; 2. Central area of head between d1 and d5 setae: integument secondary granules and muscular insertions; 3. Right fourth antennal article, ventral side; 4. Right fourth antennal article and distal part of ant. III, dorsal side; i: i-seta; ms: s-microchaeta; or: distal organite; s1 to s4: s-setae of ant. III organite; x: ordinary distal seta belonging probably to ant. III; 5. labial, peri-labial and post-labial setae; 6. Maxilla and mandible, dorsal view; fulcrum with arm, I.P.P. and E.P.P. (cf text); md: mandible; st: stipa; 7. Dorsal chaetotaxy; setae used in descriptions are named; ms: s-microchaeta of thorax.

species and reduced from the basic pattern in Hypogastruridae: sd1, sd2 and d4 are absent (fig. 7). (6) Presence/absence of m1 and a3/4 setae on th. II-III (thoracic segments II-III), of m1 and m3 on abd. IV and of a1 on abd. V. (7) Relative position of axial setae.

The strong paurochaetosis that occurs in Odonellidae results in some uncertainty about the exact nomenclature of the remaining setae. For example, it was difficult to say whether the second seta of the a-row on th. II was a3 or a4; so, it was named a3/4.

Appendices and ventral chaetotaxy. — (1) Trochanter. Number of setae (stable in the species examined here). (2) Femur. Number of setae. (3) Tibiotarsus. Number of setae (proximal + distal whorls). Important paurochaetosis from the primitive pattern 19, 19, 18 of Poduromorpha. (4) Tenant hair of tibiotarsus. (5) Unguiculus. Always absent in the species studied. (6) Ventral tube. Always 3 + 3 setae in the species described here, the same as found in the first instar of Poduromorpha (primitive state). (7) Ventral setae of abd. I, II and III. (8) Dentes and mucro. Few noticeable variation in our species which have always a large mucro compared to dens. Ratio dens/mucro (d/m).

Anal spines. — Length and morphology. Anal spines are not derived from setae, but directly from integument secondary granules. Only *S. longispina* has spine-like anal spines.

SYSTEMATIC PART

Material is deposited in the collection of Laboratoire de Zoologie, Université Paul Sabatier (Toulouse).

Superodontella ciconia sp. n. (figs. 1-7)

Type material. — Holotype young female, Doi Inthanon, 2500 m a.s.l., humus, 2.I.81, sample n° THA 72, Deharveng leg; 49 paratypes from numerous samples, same station, 2000-2500 m, litter, humus and moss, 2 & 9.I.81 and 1.VIII.85, Deharveng and Gouze leg.

Description. — Colour pale blue. Length up to 1.5 mm.

Integument granulations (figs. 1 & 2). — Roundish to polygonal secondary granules all over the body, thickened on abd. VI which is globular. On head, muscular insertions convex and 5-6 secondary granules between d3 and d5 setae.

Antennae (figs. 3 & 4). — Ant. IV chaetotaxy as follows: a large apical swelling of the integument; dorso-distally 1 small ovoid organite (or) and 1 very small s-microchaeta (ms); 9 rather long subcylindrical s-setae (the lateral ones slightly longer and strongly bent), of which 7 are dorsal and 2 ventro-lateral; dorsally and ventrally 16 long slender mou-

setae ("soies mousses", Deharveng 1981b), 10-15 short pointed setae (including the dorsal i-seta); ventrally 11 rather long trumpet-setae.

Ant. III organite composed of 2 long bent s-setae (s1 et s4), 2 swollen rods (s2 and s3) and an extremely minute, triangular, s5 microchaeta. Ant. III, ant. II, ant. I with 15-16, 10, 6-7 ordinary setae respectively.

Ocular area. — 5 + 5 subequal eyes; a few swellings in the center of the ocular field; postantennal organ amboid with 4 lobes, the posterior one very reduced.

Buccal area (figs. 5 & 6). — Buccal cone subcylindrical, slender and elongate. Labium with only 3 setae: F much longer than G, E very small, f absent, without distinct apical small spines. Perilabial area with 4 + 4 setae: b3 and b4 very long, b1 and b2 shorter. Postlabial m1 seta more than twice as long as b1; p1 absent. Maxilla stipa bowed; I.P.P. and E.P.P. apparently articulated with fulcrum arm; I.P.P. slightly longer than E.P.P.; a single mandible present on the right side, as long as the stipa, with arm bent at apex.

Dorsal chaetotaxy (fig. 7). — Ordinary setae subequal, smooth and pointed, not long except on abd. VI; s-setae quite similar in length and morphology to ordinary setae, slightly thinner (position from th. II to abd. V: 3, 3/4, 4, 4, 4, 4, 3). On head, c2 present. Th. II, th. III and abd. IV with m1 present, abd. V with a1 present.

Appendices and ventral chaetotaxy. — As follows:

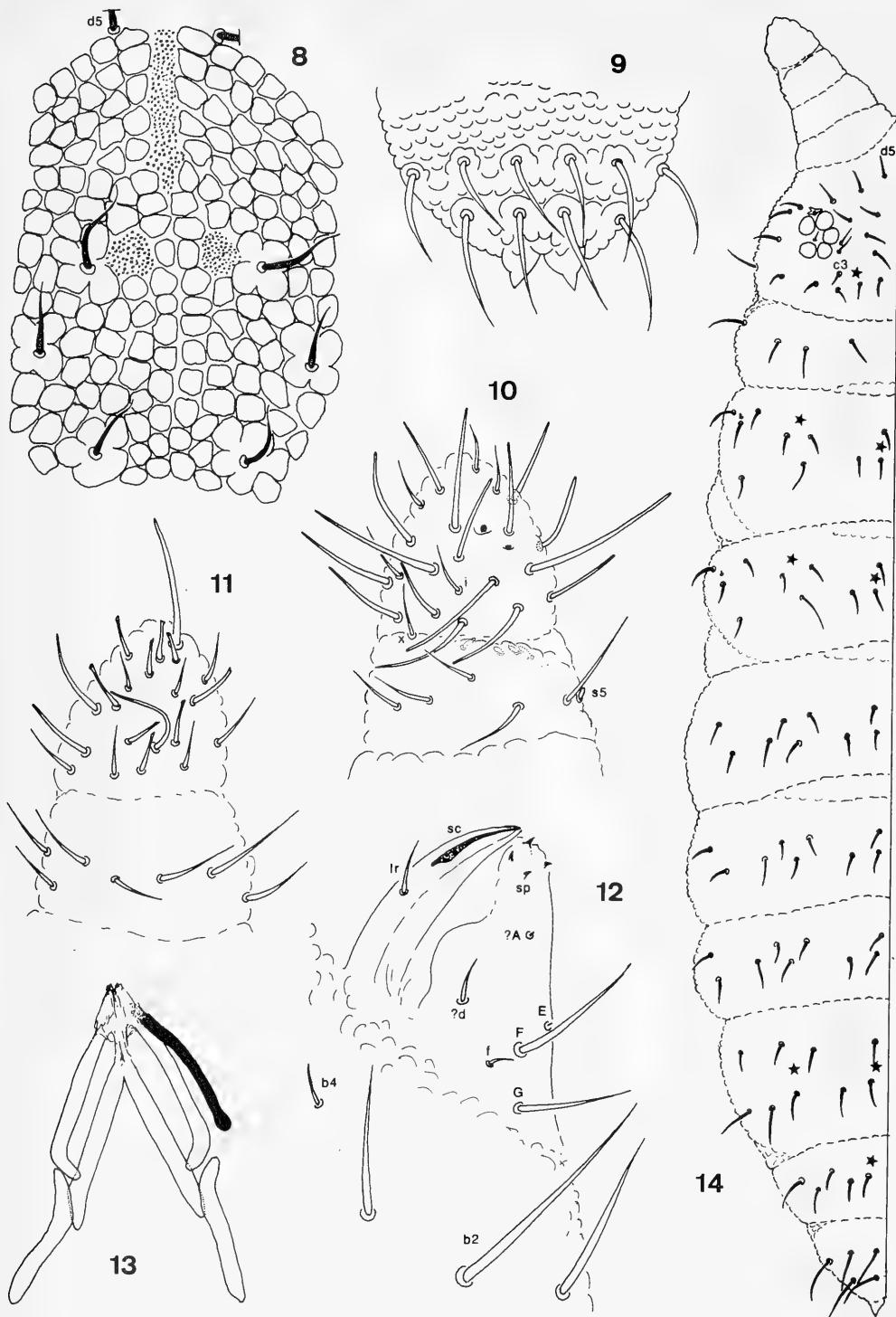
	Tr	F	T
LI	5	10	6 + 10
LII	5	10	6 + 10
LIII	4	9	5 + 10
abd. I	TV:3		
abd. II	Ve: 3		
abd. III	Ve: 5		

Distal whorl of tibiotarsus with one acuminate tenant hair. Unguiculus absent. Dentes with 5 + 5 dorsal setae, the 3 internal ones stronger; mucro typical of the genus, as long as the dentes.

Anal spines (fig. 1). — Rather short, with strong granular papillae.

Derivatio nominis. — The species is named for its long and thin buccal cone.

Discussion. — Only one *Superodontella* species with very long and thin mouth parts has been described, *S. cornuta* Yosii, 1965 from Japan. It differs from *S. ciconia* by the presence of spiniform setae on ant. I-II and coxae, apically swollen tenant hairs on tibiotarsi and clavate setae on abd. VI tergite. The axial chaetotaxy of tergites is the same in the two species but the complete dorsal chaetotaxy of *S. cornuta* has not been described.



Superodontella gouzei sp. n.
(figs. 8 to 14)

Type material. — Holotype male, Doi Inthanon, 2500 m a.s.l., moss on rock, 1.VIII.85, sample n° CL 47, Deharveng leg; 30 paratypes from numerous samples, same station, 2000-2500 m, litter, humus and moss, 2 & 9.I.81 and 1.VIII.85, Deharveng and Gouze leg.

Description. — Colour pale blue. Body length 0.7 to 1 mm (0.75 mm for the holotype male, 1 mm for a paratype female, 0.7 to 1 mm for large juveniles).

Integument granulations (figs. 8 & 9). — Roundish secondary granules all over the body; they are slightly fused around setal sockets on head and on abd. VI tergite. On head, granules ordered in two longitudinal rows (axial area) and in oblique rows (frontal area); 8 secondary granules between d3 and d5; muscular insertions as fig. 8.

Antennae (figs. 10 & 11). — Ant. IV chaetotaxy as follows: no swelling of the integument at the apex; dorso-distally, 1 small ovoid organite (or) and 1 very small s-microchaeta (ms); dorsally and ventrally about 20 long *mou-setae* (including non differentiated s-setae), 12-13 rather short pointed ordinary setae (including the dorsal i-seta); ventrally 9-10 fairly long trumpet-setae.

Ant. III organite composed of 5 ovoid short s-setae hidden under an integument fold; s1 and s4 longer than the others. Ant. III, ant. II, ant. I with only 12-13, 10, 7 ordinary setae.

Ocular area. — 5 + 5 subequal eyes with a few swellings in the center of ocular field; postantennal organ amiboid with 4 lobes, the posterior one very reduced.

Buccal area (figs. 12 & 13). — Buccal cone short and wide. Labrum with 1 + 1 setae and a pair of longitudinal sclerotized structures. Labium with 6 setae; G and F long, f short, E and ?A very short, hardly distinct at higher magnification, ?d rather short; 4 small spines on the reduced distal part. Perilabial area with 4 + 4 setae: b2 very long, b1 and b3 subequal, b4 much smaller than the others; postlabial m1 seta slightly longer than b1; p1 absent. Maxillary stipe straight, oblique and bent at the tip towards fulcrum; I.P.P. and E.P.P. apparently articulated with fulcrum arm; I.P.P. twice longer than

Table 1. Differences between *Superodontella gouzei* and *S. salmoni*.

	<i>S. gouzei</i>	<i>S. salmoni</i>
s2 and s3 setae on ant. III	oval, short	T-shaped
2 anterior ocelli	subequal to others	larger than others
labial setae	?A<E<f<?d<G<F	?d,f,F,G subequal

E.P.P.; presence on the right side of a single mandible shorter than the stipe, with rounded arm apex.

Dorsal chaetotaxy (fig. 14). — Ordinary setae subequal, smooth and pointed, not long except on abd. VI; ratio s-seta/ordinary seta decreasing from 2 to nearly 1 from thorax to abd. V (position from th. II to abd. V: 3, 3/4, 4, 4, 4, 3). On head, c2 absent. Th. II-III with m1 and a3/4 absent; abd. IV with m1 and m3 absent, abd. V with a1 absent.

Appendices and ventral chaetotaxy. — As follows:

	Tr	F	T
LI	5	11	6 + 9
LII	5	11	6 + 9
LIII	4	10	5 + 9
abd. I	TV:3		
abd. II	Ve:3		
abd. III	Ve:4		

Distal whorl of tibiotarsus with one acuminate tenent hair. Unguiculus absent. Dentes with 5 + 5 dorsal setae, the 3 internal ones stronger; mucro typical of the genus, as long as the dentes.

Anal spines. — Short (fig. 9).

Derivatio nominis. — This species is dedicated to our friend Alain Gouze who participated to the collection of the species in 1981.

Discussion. — *S. gouzei* is a near relative of *S. salmoni* Massoud, 1965 from New Guinea by its reduced chaetotaxy, setae morphology, small anal spines and short buccal cone. Differences are listed in table 1. Type specimens of *S. salmoni* have been examined but details of antennal chaetotaxy as well as maxilla and mandible could not be observed on this material.

Figs. 8-14. *Superodontella gouzei* sp. n. — 8. Central area of head between d1 and d5 setae: integument secondary granules and muscular insertions; 9. Abdomen VI tergite; 10. Right third and fourth antennal articles, dorsal side; i: i-seta; s5: external s-seta of ant. III organite, x: ordinary distal seta belonging probably to ant. III; 11. Right third and fourth antennal articles, ventral side; 12. Labral, labial and perilabial setae, lateral view; lr: labral seta; sc: distal sclerotized structure of labrum; sp: small distal spines; 13. Maxilla and mandible, dorsal view; 14. Dorsal chaetotaxy; starts: setae absent compared with pattern in *S. ciconia*.

Superodontella longispina sp. n.
(figs. 15-21)

Type material. — Holotype male, Doi Inthanon, 2500 m a.s.l., moss on rock, 1.VIII.85, sample n° CL47, Deharveng leg; 14 paratypes from 12 samples, same station, 2000-2500 m, litter and humus, 2 & 9.I.81, 1.VIII.85 and 23.VI.86, Bedos, Deharveng and Gouze leg.

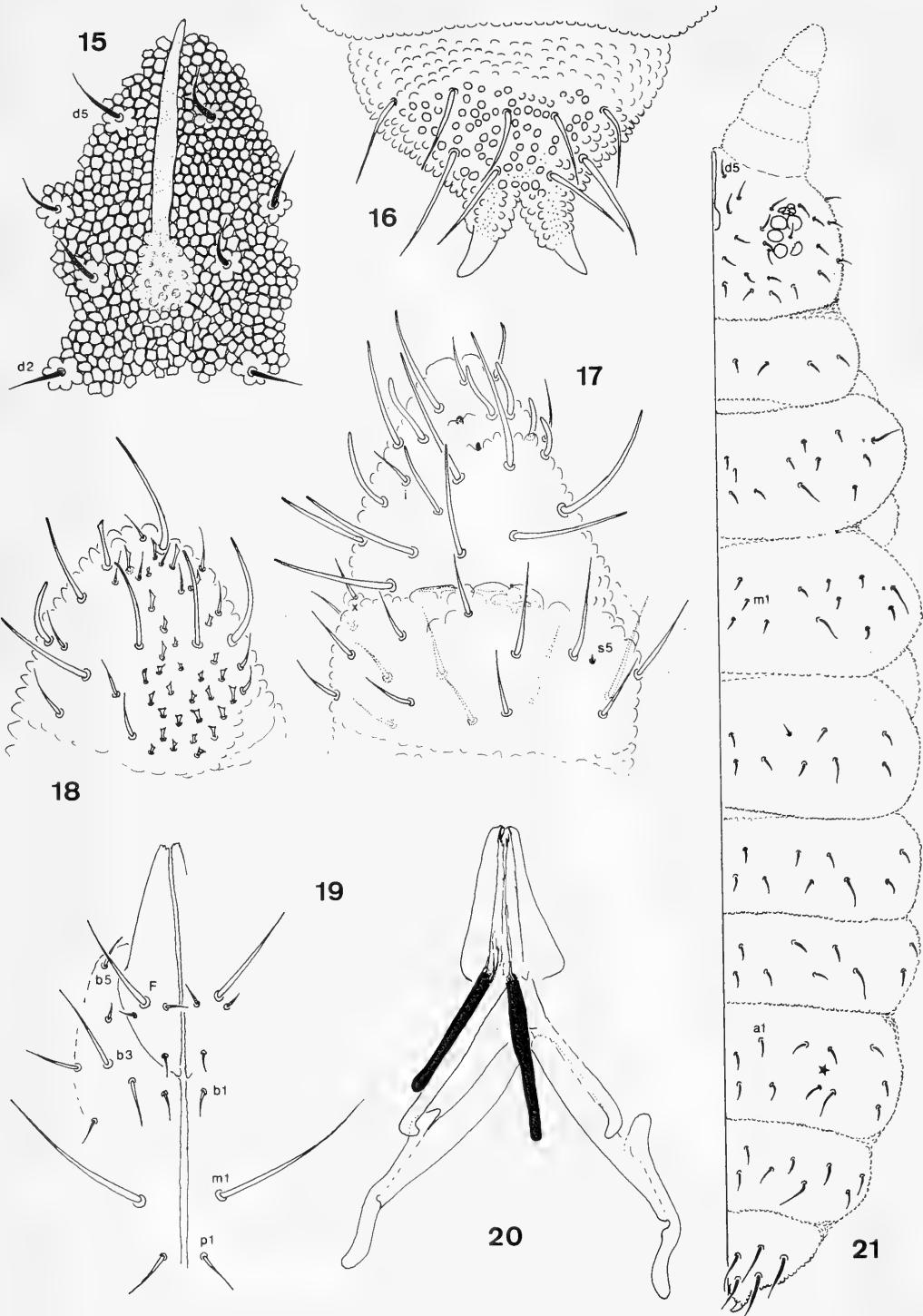


Table 2. Differences between *Superodontella longispina*, *S. distincta*, *S. nepalica* and *S. macronychia*.

	<i>S. longispina</i> sp. n. (Thailand)	<i>S. distincta</i> Yosii, 1954 (Japan)	<i>S. nepalica</i> Yosii, 1971 (Nepal)	<i>S. macronychia</i> Prabhoo, 1976 (India)
apical swelling on ant. IV	absent	present	present	?
rows of setae on abd. IV	3	3	?2	2
internal teeth of unguis	basal	about 1/3 from basis	basal	"median"
tibiotarsus tenant hair	long, acuminate	long, capitate	acuminate, not differentiated	same as <i>nepalica</i>
anal spines	long, pointed	long, pointed	"smaller than in <i>O. distincta</i> ", pointed	long, large, subcylindrical and truncated

Description. — Colour grey blue, white muscular insertion, conspicuous in alcohol. Body length up to 1.5 mm.

Integument granulations (figs. 15 & 16). — Roundish or hexagonal secondary granules all over the body, of small size (12 secondary granules between d3 and d5 setae on head), more convex and thickened on abd. VI; granules joint around setae sockets. Muscular insertions conspicuous, especially a median longitudinal one on head as fig. 15.

Antennae (figs. 17 & 18). — Ant. IV chaetotaxy as follows: no apical swelling; dorso-distally, 1 small ovoid organite (or) and 1 very small s-microchaeta (ms); 7-8 rather long subcylindrical s-setae (1 thinner), dorsal and ventro-lateral; dorsally and ventrally 16 long slender mou-setae and 15-16 short pointed setae (including the dorsal i-seta); 31 short ventral trumpet-setae and 2 long ones at the apex.

Ant. III organite composed of 4 T-shaped s-setae (s1 to s4) under an integument fold and an extremely minute, triangular, s5 microchaeta. Ant. III, ant. II, ant. I with 18, 10, 7 ordinary setae.

Ocular area. — 5 + 5 subequal eyes; about 30 secondary granules in the center of the ocular field; postantennal organ hypogastruroid with 4 large, well separated lobes.

Figs. 15-21. *Superodontella longispina* sp. n. — 15. Central area of head between d2 and d5 setae: integument secondary granules and muscular insertions; 16. Abdomen VI tergite; 17. Right third and fourth antennal articles, dorsal side; stippled setae are on ventral side of ant. III, except s1-s4 of organite which are dorsally covered with an integument fold; i: i-seta; s5: external s-seta of ant. III organite; x: ordinary distal seta belonging probably to ant. III; 18. Right fourth antennal article, ventral side; 19. Labial, perilabial and postlabial setae; 20. Maxilla and mandibles, dorso-lateral view; 21. Dorsal chaetotaxy; stars: setae absent compared with pattern in *S. ciconia*.

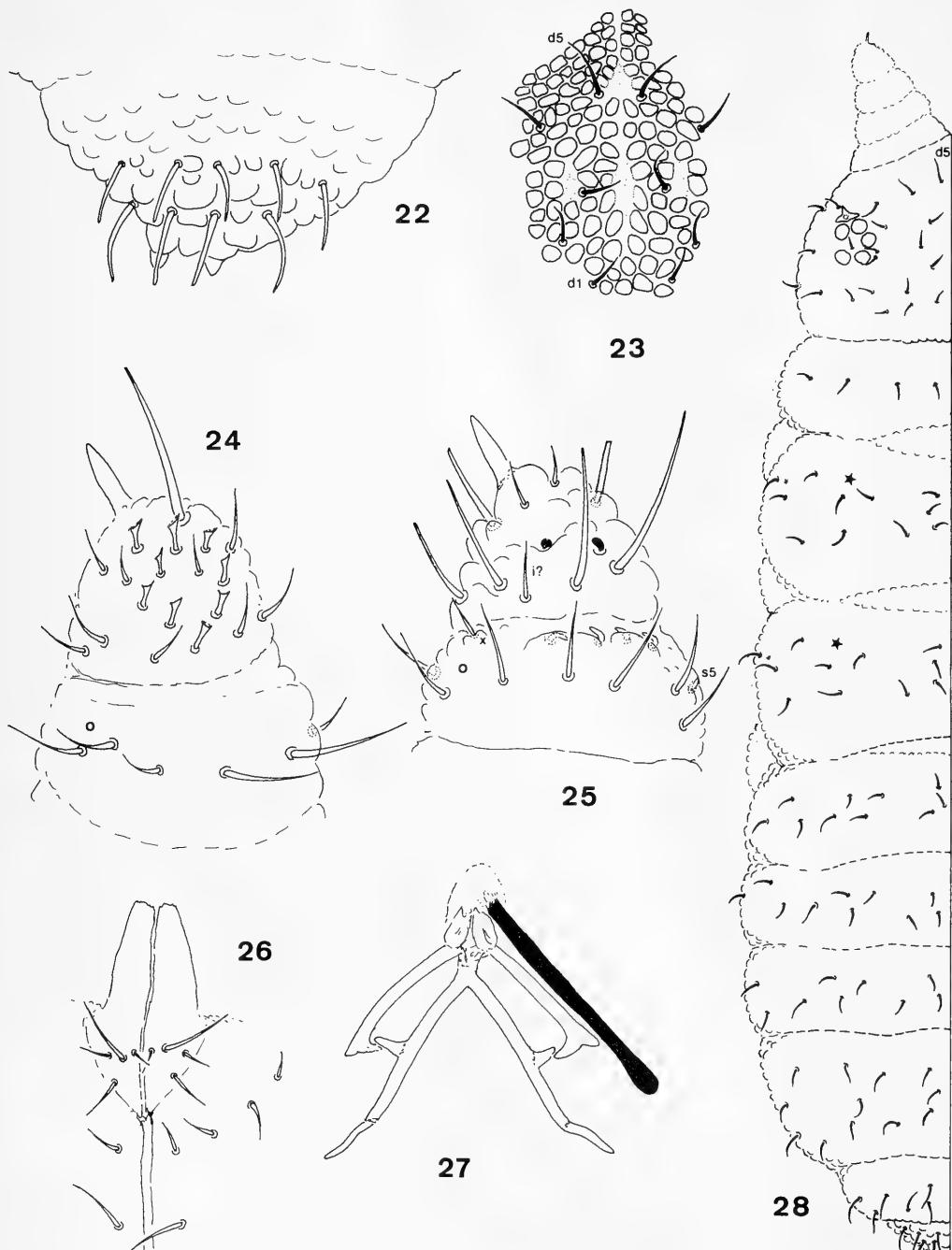
Buccal area (figs. 19 & 20). — Buccal cone strongly protruded. Labium devoid of distal small spines, with 4 setae: F long, the others short. Perilabial area with 5 + 5 setae: b3 long, b1, b2, b4 and a fifth seta (b5) short; postlabial m1 seta more than 5 times longer than b1; p1 present or absent, short. Maxilla fulcrum very strong; I.P.P. and E.P.P. apparently partially articulated with fulcrum arm; E.P.P. reduced and more or less fused to fulcrum arm; stipa rather thin with apex bent towards the fulcrum; 2 small mandibles present with rounded apices, the right one slightly longer.

Dorsal chaetotaxy (fig. 21). — Ordinary setae subequal, smooth and pointed, not long, except on abd. VI where setae are longer, stronger and acuminate (sometimes slightly capititated); ratio s-seta/ordinary seta decreasing from 3 to nearly 2 from thorax to abd. V (position from th. II to abd. V: 3, 3/4, 4, 4, 4, 3). On head, c2 present. Th. II, th. III and abd. IV with m1 present, abd. V with a1 present; on th. II and th. III, m1 not aligned with a1 and p1; on abd. IV, a1 shifted from the axis and m3 absent.

Appendices and ventral chaetotaxy. — As follows:

	Tr	F	T
LI	5	12	7 + 10
LII	5	11	7 + 10
LIII	4	10	6 + 10
abd. I	TV:3		
abd. II	Ve: 3		
abd. III	Ve:4		

Setae of coxae nearly spiniform. Distal whorl of tibiotarsus with one tenant hair very long and acuminate. Unguiculus absent. Unguis with 1 basal inner tooth and 1 + 1 strong laterobasal teeth. Dentes with 5 + 5 dorsal setae, the 3 internal ones much stronger; mucro typical of the genus, shorter than the dentes ($d/m = 1.6$).



Figs. 22-28. *Superodontella flammatata* sp. n. — 22. Abdomen VI tergite; 23. Central area of head between d1 and d5 setae; integument secondary granules and muscular insertions; 24. Right third and fourth antennal articles, ventral side; circles: setae present in some specimens; 25. Right third and fourth antennal articles, dorsal side; i: i-seta; s5: external s-seta of ant. III organite (ventral); x: ordinary distal seta belonging probably to ant. III; circles: setae present in some specimens; 26. Labial, perilabial and postlabial setae; 27. Maxilla and mandible, dorsal view; 28. Dorsal chaetotaxy; stars: setae absent compared with pattern in *S. ciconia*.

Table 3. Differences between *Superodontella flammata*, *S. gladiolifer* and *S. biwonensis*.

	<i>S. flammata</i>	<i>S. gladiolifer</i>	<i>S. biwonensis</i>
apical digitation of ant. IV	present	present	absent
thickened s-setae on ant. IV	0	0	9
c2 setae on head	present	absent	present
basal labial setae	3 rather long, 1 very long	3 short (a fourth could have been overlooked)	?
m1 on th. II-III, abd. IV	present	absent	present
s setae/ordinary setae on th. II-III	#1,2	#3	#1,2
anal spines	minute	well developed	absent

Anal spines. — Strong, with very long granular papillae (fig. 16).

Derivatio nominis. — The species is named for its long anal spines.

Discussion. — Three species of *Superodontella*, all from Asia, have strong anal spines, large and rather long buccal cone and T-shaped sensory rods on ant. III like *S. longispina*. On the basis of the original descriptions, we can give the differential characters as mentioned in table 2. A redescription of the species *S. distincta*, *S. nepalica* and *S. macronychia* would be however necessary to precise their real taxonomic status: we lack data about antennal and dorsal chaetotaxy as well as morphology of maxilla and mandible in these species.

Superodontella flammata sp. n. (figs. 22-28)

Type material. — Holotype juvenile, Doi Inthanon, 2500 m a.s.l., litter and humus near a bog, 2.I.81, sample n° THA 66, Deharveng leg; 4 paratypes in 4 samples, same station, 2500 m, litter and humus, 2 & 9.I.81, Deharveng and Gouze leg.

Description. — Colour pale blue. Body length 0.55 to 0.72 mm (no adult observed). Antennae short and conical.

Integument granulations (figs. 22 & 23). — Rather flat, roundish secondary granules all over the body, enlarged on abd. VI. On head, 2 median and 2 small lateral muscular insertions and 4 secondary granules between d3 and d5 setae.

Antenna (figs. 24 & 25). — Ant. IV chaetotaxy as follows: no apical swelling but a long distal flame-shaped digitation; dorso-distally, 1 small ovoid organite (or) and 1 small s-microchaeta (ms); dorsally and ventrally 5 long slender mou-setae, 12 short pointed setae (including the dorsal i-seta); 9-10 short ventral and 2 long apical trumpet-setae.

Ant. III organite composed of 5 short and bent s-

setae. Ant. III, ant. II, ant. I with 14-16, 10, 6-7 ordinary setae.

Ocular area — 5 + 5 subequal eyes; postantennal organ amiboid with 4 lobes, the posterior one very reduced.

Buccal area (figs. 26 & 27). — Buccal cone rather long. Labium with 4 setae: F very long, others medium with G longer than E and f. Perilabial area with 4 + 4 subequal setae; postlabial m1 seta slightly longer than b1; p1 absent. Maxilla fulcrum long and thin; distal part of I.P.P. apparently articulated; E.P.P. nearly four times shorter than I.P.P.; I.P.P., fulcrum arm and stipa of equal length; presence of a single mandible on the right side, longer than the stipa, with enlarged arm apex.

Dorsal chaetotaxy (fig. 28). — Ordinary setae subequal, smooth and pointed, not long, longer on abd. VI; s-setae slightly longer and thinner than ordinary setae (position from th. II to abd. V: 3, 3/4, 4, 4, 4, 3). On head, c2 present. Th. II, th. III and abd. IV with m1 present, abd. V with a1 present; on th. II and th. III, a3/4 absent.

Appendices and ventral chaetotaxy. — As follows:

	Tr	F	T
LI	5	11	7 + 9
LII	5	11	7 + 9
LIII	4	10	6 + 9
abd. I	TV:3		
abd. II	Ve:3		
abd. III	Ve:3		

Distal whorl of tibiotarsus with one acuminate tenent hair, slightly differentiated. Unguiculus absent. Dentes with 5 + 5 dorsal setae, the 3 internal ones stronger; mucro typical of the genus, nearly as long as the dentes ($d/m = 1.2$).

Anal spines. — Reduced to minute integument swellings (fig. 22).

Derivatio nominis. — The species is named for its flame-shaped digitation at the antennal apex.

Discussion. — In the presence of a long and thin digitation at the apex of antenna, this new species is near *S. gladiolifer* Massoud, 1965 from New Guinea. In the other characters, it seems to be closely related to *S. biwonensis* Lee, 1974 from South Korea. Differences are summarized in table 3.

REFERENCES

Deharveng, L., 1981a. La famille des Odontellidae: phylogénèse et taxonomie. — Travaux du Laboratoire d'Écobiologie des Arthropodes Edaphiques, Toulouse 3 (1): 1-21.

Deharveng, L., 1981b. La chétotaxie dorsale de l'antenne et son intérêt phylogénétique chez les Collemboles Neanuridae. — Nouvelle Revue d'Entomologie 11 (1): 3-13.

Gama, M. M. da, 1988. Filogenia das espécies de *Xenylla* à escala mundial (Insecta, Collembola). — Evolucion Biologica 2: 139-147.

Massoud, Z., 1967. Monographie des Neanuridae, Collemboles poduromorphes à pièces buccales modifiées. — Biologie de l'Amérique Australe 3: 7-399.

Stach, J., 1949. The apterygotan fauna of Poland in relation to the world fauna of this group of insects: families Neogastruridae and Brachystomellidae. — Acta Monographica Musei Historiae Naturalis, Kraków: 341 pp.

Yosii, R., 1971. Collembola of Khumbu Himal. — Khumbu Himal 4 (1): 80-130.

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**PROGOMPHUS NIGELLUS AND PHYLLOCYCLA
HAMATA, TWO NEW DRAGONFLIES FROM BRAZIL
(ODONATA: GOMPHIDAE)**

Belle, J., 1990. *Progomphus nigellus* and *Phyllocycla hamata*, two new dragonflies from Brazil (Odonata: Gomphidae). – Tijdschrift voor Entomologie 133: 27-30, figs. 1-10. [ISSN 0040-7496]. Published 31 July 1990.

Descriptions and illustrations are given of two new species of Gomphidae (Odonata) from Brazil, viz. *Progomphus nigellus* and *Phyllocycla hamata*. Both male holotypes were collected in Brazil, State of Rondonia, Fazenda Rancho Grande.

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Key words. — Brazil; *Progomphus*; *Phyllocycla*; new species.

INTRODUCTION

To the courtesy of Dr. Rosser W. Garrison at Azusa, California, I had the pleasure of receiving for description two new gomphid species which he had collected himself during his investigations in the area southwest of Ariquemes in the State of Rondonia, Brazil. The material in question consists of three males; the corresponding females still remain to be discovered. The new taxa are here published under the names *Progomphus nigellus* and *Phyllocycla hamata*. The holotypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; the paratype is in the collection of Dr. Garrison.

Progomphus nigellus spec. nov. (figs. 1-6)

Material. — Brazil: State of Rondonia, Fazenda Rancho Grande, 62 km SW of Ariquemes ($10^{\circ} 50' S$, $63^{\circ} 7' W$, 187 m), 2-11 November 1989, 1 ♂ (holotype), R. W. Garrison.

This species is the fourth member of the *guyanensis* group to which also belong *Progomphus guyanensis* Belle, 1966, *Progomphus approximatus* Belle, 1966 and *Progomphus boliviensis* Belle, 1973. The males of this infrageneric group differ from those of the closely allied *complicatus*-group in having the superior anal appendages armed with a sharply-pointed basal ex-tero-lateral dilatation.

Progomphus nigellus is perhaps as nearly related to *Progomphus boliviensis* as to the other two members of the group. The male superior anal appendages are similar to those of *boliviensis*, the inferior anal appendage approaches more that of *approximatus* while the anal tubercles resemble

those of *guyanensis*. The morphological differences and similarities in the terminalia of the abdomen will be seen by comparing the figures of the present species with the corresponding ones of the other three members earlier published by me (Belle 1966, 1973).

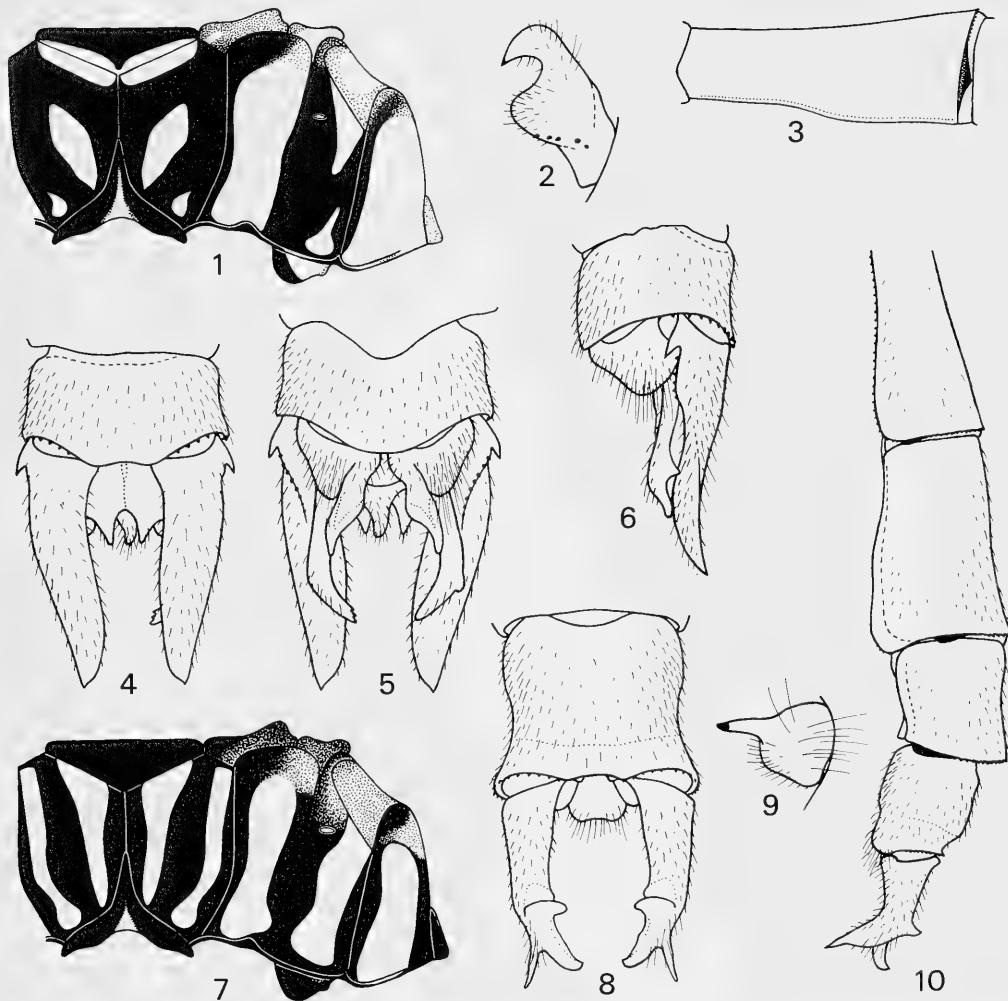
In order not to tamper with the unique specimen I have studied the accessory genitalia *in situ*. This can easily be done because the posterior hamules are in a somewhat extruded position. The accessory genitalia then exhibit a great resemblance to those of *boliviensis*.

Male (holotype). — Total length 38 mm; abdomen (incl. app.) 29 mm; hind wing 22.5 mm; costal edge of pterostigma of fore wing 2.7 mm.

Smaller and more delicate than the other members of the group. Coloration done in black, brown and greenish white (= pale) but the pale markings on the abdomen are yellow. Face predominantly pale, slightly tinged brown at posterior parts of labrum and postclypeus. Superior surface of frons and occipital plate pale. Vertex brown. Rear of head brown with a pair of small submedian pale spots on top and a pair of larger pale markings on tempora. Crest of occiput slightly and evenly concave, thinly fringed with pale hairs which are about as long as half the middorsal length of the occipital plate.

Prothorax with pale middle lobe and black hind lobe. Thoracic colour pattern black with pale markings, resembling that of *boliviensis* but with metepimeral pale stripe partly developed and interrupted in middle (fig. 1).

Legs dark brown but inner side of first femora pale and second and third femora becoming lighter brown toward the bases.



Figs. 1-10. — 1-6, *Progomphus nigellus* spec. nov., male holotype; 1, diagram of thoracic colour pattern; 2, right posterior genital hamule, ventral; 3, seventh abdominal segment, left profile; 4, tenth abdominal segment and anal appendages, dorsal; 5, the same, ventral; 6, the same, left profile. — 7-10. *Phyllocycla hamata* spec. nov., male holotype; 7, diagram of thoracic colour pattern; 8, tenth abdominal segment and anal appendages, dorsal; 9, right posterior genital hamule, ventral; 10, apical segments of abdomen and anal appendages, left profile.

Wings with a brown tinge, blackish brown venation and brown pterostigma. Brace vein present. Ante- en postnodal cross-veins of first series 10:14-16:12/11-11-11:10 in fore and hind wings, respectively. Second primary antenodal cross-vein the fifth. Basal subcostal cross-vein present. All supratriangles one-celled. All subtriangles and triangles two-celled with two rows of cells following but with an extra initial cell at hind angle of triangle in hind wings. Intermedian cross-veins 7-7/5-4 in fore and hind wings, respectively. Anal field of fore wing

two cells wide for a distance of two cells. Hind wings with five paranal cells, three (left) and four (right) postanal cells, three rows of cells behind Cu₂, and a three-celled anal triangle.

Abdomen predominantly dark brown or blackish brown. Terminalia of abdomen black, including upper surface of superior anal appendages (contrary to the other members of the group which have the apical part of the upper surface pale or partly pale). Sides of segments 1 and 2 largely yellow. Sides of segments 3 to 7 with a small, yellow basal

spot. Middorsum of segment 2 with a round yellow spot that tapers to hind border of segment. Segments 3 to 7 with a middorsal yellow line over whole length of segment, the line being very fine on segments 4 to 7. There is no tubercle of any sort on venter of segment 1. Segment 7 slightly widening on apical half of segment (fig. 3). Posterior genital hamule and anal appendages shaped as shown in the accompanying figures. Tip of branches of inferior anal appendage ending with three teeth.

In his letter of 7 April 1990, Dr. Garrison informed me, that he had collected this male on a trail at about 4:00 p.m., just before it rained, in company with a male of *Aphylla dentata* Selys. In addition to these species and *Phyllocycla hamata* spec. nov. described below, he had also taken *Zonophora calippus klugi* Schmidt and *Phyllogomphoides cepheus* Belle in the same environment.

Phyllocycla hamata spec. nov.

(figs. 7-10)

Material. — Brazil: State of Rondonia, Fazenda Rancho Grande, 62 km SW of Ariquemes ($10^{\circ} 50' S$, $63^{\circ} 7' W$, 187 m), 2-11 November 1989, 2 ♂ (holotype and paratype), R. W. Garrison.

This species is the seventh member of the *volsella* group (cf. Belle 1988). Dr. Garrison recognized it as an undescribed species and wrote from Azusa on 19 February 1990 to me that the males are nearest to my *armata* but whose morphology of the appendages is different. The species is peculiar by the huge hook which arises erect on the upper surface of each male superior anal appendage.

Male (holotype; abdomen broken between segments 4 and 5). — Total length 43 mm; abdomen (incl. app.) 33 mm; hind wing 25.5 mm; costal edge of pterostigma of fore wing 2.9 mm.

Head brown with pale (= leaden grey) markings. Labrum lighter brown along free border and with a symmetric pair of weakly developed pale spots. External surface of genae largely pale. Anteclypeus pale. Postclypeus with a pale spot on each lateral side. Superior surface of frons pale, darker on the middle line. Rear of head lighter on tempora. Crest of occiput slightly concave, fringed with brown hairs which are about as long as the middorsal length of occipital plate.

Prothorax black above. Pterothorax black to dark brown with pale (grey to grey-green) stripes; its colour pattern shaped as shown in diagram (fig. 7).

Femora brown, but brownish yellow on inner sides of first and second femora and on posterior side of third femora basally. Distal spines of anterior outer row of third femora more or less spaced and one-fifth to one-fourth as long as local diameter of femur. Tibiae, tarsi and claws black.

Wings with a brown tinge, black venation and light brown pterostigma. Brace vein present. Ante- and postnodal cross-veins of first series 12:17-15:13/11:12-12:11 in fore and hind wings, respectively. Second primary antenodal cross-vein the fifth. Basal subcostal cross-vein present in all wings. Supratriangle in right hind wing three-celled, in other wings two-celled. Subtriangles in fore wings two-celled, in hind wings one-celled. Triangles two-celled with two rows of cells following but with an extra initial cell at hind angle of triangle in hind wings. Intermediate cross-veins 9-8/6-6 in fore and hind wings, respectively. Anal field of fore wings two cells wide for a distance of two cells in anterior row. Hind wings with four paranal cells and three postanal cells (the fourth paranal cell is the first postanal cell), a one-celled anal loop, three rows of cells behind Cu₂, and a four-celled anal triangle.

Abdomen dark brown with paler markings as follows: Sides of segments 1 and 2 largely yellow. Sides of segments 3 to 7 with yellow baso-lateral spots, the basal spots of both sides of segment 7 connected on the middorsum at extreme base. There is a yellow middorsal line on segments 2 to 7. Sides of segments 8, 9 and 10 largely brown-yellow. Lateral dilatations of segments 8 and 9 narrow and black. Lateral margins of segment 8 with four (left) and three (right) denticles at apex, those of segment 9 denticulated at extreme base. Posterior margin of segment 10 denticulated at level of bases of superior anal appendages. Dorso-apical rim of segment 10 about one-fourth the middorsal length of segment. Superior anal appendages black and shaped as shown in figs. 8 and 10. Rear margin of vesicle deeply cleft, bottom of cleft rounded and without a median elevation of any sort. Tip of posterior genital hamule rather long (fig. 9).

The male paratype lacks the tip of the left superior anal appendage but for the rest the specimen is in a perfect condition. The pale markings of the pterothorax are yellowish green and the dark lateral stripes brown. The wings are slightly brown-tinted. The cubito-anal interspace of the right hind wing has two cross-veins instead of the usual single cross-vein and the pterostigma is a trifle larger than that of the male holotype. The measurements of the male paratype are: Total length 42.5 mm; abdomen (incl. app.) 32.5 mm; hind wing 24.5 mm; costal edge of pterostigma of fore wing 3 mm.

Remark. — I take this opportunity of correcting a misprint in the description of *Phyllocycla armata* Belle, 1977. On page 7, in rule 7 from above, part of a line has been left out. We have to read: "Trigonal interspace in fore wings starting with two rows of cells from triangle outwards, that in hind wings starting with a row of three cells against triangle followed by two rows of cells."

REFERENCES

Belle, J., 1966. Surinam dragon-flies of the genus *Progomphus*. – Studies on the fauna of Surinam and other Guyanas 8: 1-28; pls. 1-4.

Belle, J., 1973. A revision of the New World genus *Progomphus* Selys, 1854. – Odonatologica 2: 191-308.

Belle, J., 1977. A new species of *Phyllocycla* Calvert, 1948 from Brazil (Odonata: Gomphidae). – Entomologische Berichten, Amsterdam 37: 6-7.

Belle, J., 1988. A synopsis of the species of *Phyllocycla* Calvert, with descriptions of four new taxa and a key to the genera of Neotropical Gomphidae (Odonata, Gomphidae). – Tijdschrift voor Entomologie 131: 73-102.

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A BIOGEOGRAPHIC ACCOUNT OF THE GRASSHOPPERS (ORTHOPTERA: ACridoidea) OF SULAWESI, INDONESIA

Monk, K. A. & R. K. Butlin, 1990. A biogeographic account of the grasshoppers (Orthoptera: Acridoidea) of Sulawesi, Indonesia. – *Tijdschrift voor Entomologie* 133: 31-38, tabs. 1-4. [ISSN 0040-7496]. Published 31 July 1990.

Nineteen acridid species were collected from the Dumoga Bone National Park and its environs in North Sulawesi, Indonesia, during 1985: two were new to science and one was known previously only from the Philippines.

The total acridoid fauna of Sulawesi, including these three species, comprises 61 species of Acrididae (53 Catantopinae, four Oedipodinae, three Acridinae, one Gomphocerinae) and one species of Pyrgomorphidae. This fauna has four main characteristics: (a) a high level of specific and generic-level endemism, (b) low generic-level diversity but a high number of species per genus, (c) diverse distributions outside Sulawesi, and (d) localised distributions within the island.

In the Catantopinae, 83% of species are endemic to Sulawesi, reflecting the importance of the island as an area of endemism. Species distributions within Sulawesi suggest that each region of the island (North, Central, South and South-east) may also be an area of endemism in its own right.

These observations are discussed in relation to the geological history of Sulawesi. They suggest that for much of its history the island has been more isolated from other land masses than it is at present, and that it has been fragmented either into separate islands or by ecological barriers.

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Key words. – Biogeography, Sulawesi, Wallacea, grasshoppers, endemism.

INTRODUCTION

Although the Acridoidea in temperate zones and in dry equatorial areas are well-known, only wide ranging, economically-important pests, e.g. *Oxya japonica japonica* Thunberg and *Locusta migratoria* Linnaeus, have been studied in wet equatorial areas. The taxonomic work in South-east Asia by Ramme (1941) and Willemse (1951, 1956, 1957) is an exception but it has not been extended. In particular, the acridoid fauna of Sulawesi has been largely ignored despite the great interest in other animal groups inhabiting the island.

Sulawesi lies in a deep sea region, also including the Lesser Sunda Islands (Lombok to Timor) and the Moluccas, with lies between two continental margins: the Sunda (Malaysia and the Greater Sunda Islands), and the Sahul shelves (New Guinea and offshore islands). Classically, this area was seen as the meeting point of two major biotas: the Oriental and the Australasian. Wallace (1869) originally

separated them by dividing Bali (and Borneo) from Lombok (and Sulawesi). Although Wallace's Line may apply to some groups such as freshwater fish and mammals, the diversity of biogeographical patterns across this region for different taxonomic groups is high (see George 1987). Even with this overlap of broad transitional zones, Wallacea (a collective term for the islands of the deep sea region) is generally considered to be insular and biotically impoverished, but with unique characteristics indicating long periods of isolation (Dickerson et al. 1928).

Sulawesi covers 159,000 km² divided into four regions, Utara, Tengah, Selatan, and Tenggara, or North, Central, South, and South-east Sulawesi, respectively (see Whitten, Mustafa & Henderson 1987, for geographical details). North Sulawesi is a narrow peninsula, 772 by 103 km. Volcanoes, 1800-2400 m above sea level (asl), range along the peninsula. Seismic activity was recorded during 1985 and

1986. Limestone outcrops (possibly Cretaceous) occur in the western half of North Sulawesi. The northern peninsula is linked with Central Sulawesi by a narrow neck of land at the western extremity. The Sangihe and Talaud Islands lie between the northern tip of North Sulawesi and the Philippines. Central Sulawesi is also mountainous, with peaks reaching 2000-3000 m asl. A limestone mountain range running north to south through South Sulawesi is 500-1000 m asl and bisected by a narrow plain. The lakes on the plain are only 1-2 m deep and were once part of the sea, suggesting that at least this peninsula may have been partially submerged at times. The single volcano in this region, Lompobatang (2871 m asl), is extinct. The peninsula of South-east Sulawesi has a western mountain range reaching 2800 m asl and a lower-lying eastern area.

The vegetation is affected by regional climatic differences. Central Sulawesi has the greatest ratio of wet to dry months, whereas more seasonal rainfall occurs in the peninsulas (Whitmore 1984). The central region is covered in evergreen rain forest, whereas semideciduous forest is more common in the peninsulas (Walker 1982). Open habitats are mainly secondary, due to forest clearance for agriculture (Whitten et al. 1987).

Geologically Wallacea is a highly complex region originating in an interaction between the Southeast Asian, Australian, and Pacific plates (Charlton 1986). The present island of Sulawesi is believed to be derived from two fragments that originated separately during the breakup of east Gondwanaland about 320 My ago, and remained separate during a northerly move starting 220 My ago (Audley-Charles 1987). From the late Cretaceous onwards, these fragments probably formed part of an archipelago between the Asian mainland and Australia-New Guinea but their positions relative to other land masses are uncertain. Holloway (1987) emphasized two alternative theories about the relationship of Sulawesi with Borneo: 1. The fragment now forming the western part of the island (North, South and part of Central Sulawesi) has always been in about its present position relative to Borneo, whereas the eastern fragment was Australasian in origin, 2. The two fragments were both isolated island arcs, now fused and thrust towards Borneo. The present island was probably formed about 15 My ago. The area of land above sea level, its division into separate islands and its climate are additional factors which must have contributed to the present day fauna of Sulawesi but about which little is known (Morley & Flenley 1987).

It is now believed that Sulawesi was never linked by land bridges to any other land mass following its formation 15 My ago (Audley-Charles 1987; Holloway 1987). During the Pleistocene, the sea level fell several times when affected by the Glacial expan-

sion of the ice caps. The largest drop, 170,000 years ago, linked Sundaland (Sumatra, Java, Bali, and Borneo) with the Asian mainland, with land extensions northward to the Philippines. Exposed land also extended around South Sulawesi toward the Lesser Sunda Islands, and from Central Sulawesi eastward toward New Guinea. During these periods of low sea level a drier, more seasonal climate prevailed and dry savannah may have extended through the Philippines to the Lesser Sunda Islands and into Australia, separating two large, wet rainforest areas in Sundaland and New Guinea; some seasonal plants still survive in South Sulawesi (van Steenis 1979). The climatic fluctuations and corresponding vegetational changes of the Quaternary are now known to have occurred in the late Tertiary as well (Morley & Flenley 1987).

MATERIALS AND METHODS

The analysis reported here is based on a combination of data from the literature and collections made by the authors and others in the Dumoga-Bone National Park, North Sulawesi during 1985. This work formed part of the Royal Entomological Society's 'Project Wallace' expedition. Insects were collected by sweeping, beating, and hand-searching. Agricultural crops, grassland, and primary semideciduous forest (undergrowth, bushes, saplings, and trees up to 2 m) were examined at all times of day and night and in three separate periods covering most of the year. Specimens collected from the tree canopy during the British Museum (Natural History) fogging programme (N. Stork, unpublished) were also examined.

The principal published records of the acridid fauna of Sulawesi are: Ramme (1941), Dirsh (1954), Willemse (1951, 1956, 1957, 1968), Hollis (1968, 1971, 1975), Kevan & Chen (1969), and Ritchie (1982). Family and subfamily classification follows that adopted in the collection of the British Museum (Natural History).

RESULTS

Expedition collection of North Sulawesi Aridoidea

Nineteen species from eighteen genera of Aridoidea were found in the Dumoga Bone National Park and its environs during 1985 (table 1). This includes two undescribed catantopine species, from the genera *Tarbaleus* and *Bibracte*, both of which were collected from the canopy by fogging. One species, *Eoscyllina luzonica*, was previously known only from the Philippines and was collected only from limestone grassland in the western part of the National Park. This suggests that the data available in the literature on the species present in Sulawesi

Table 1. Species of Acridoidea occurring in Sulawesi and their distributions.

			Wings ¹		Distribution ²	
					Outside	Within
Pyrgomorphidae						
Atractomorpha						
Acrididae						
Acridinae						
Acrida						
Calliphlaeoba	<i>psittacina</i>	<i>psittacina</i> de Haan	+	W	Across S, P	All
Phlaeobacris	<i>willemsei</i>	Dirsh	+	W	Across S, P	All
Gomphocerinae	<i>celebensis</i>	Ramme	+	B	Sulawesi	N, C
Eoscyllina	<i>reticulata</i>	Willemse		W	Sulawesi	C
Oedipodinae	<i>luzonica</i>	Bolivar I	+	W	P	N
Heteropternis	<i>obscurella</i>	Blanchard	+	W	Across	All
Aiolopus	<i>thalassinus tamulus</i>	Fabricius	+	W	Across	All
Locusta	<i>migratoria</i>	Linnaeus	+	W	Across	All
Gastrimargus	<i>marmoratus</i>	(Thunberg)		W	Across	All
Catantopinae – Endemic genera						
Alectorolophus	<i>deceptor</i>	Ramme	+	B	—	SE, N
	<i>obscoenus</i>	Brunner von Wattenwyl	+	B	—	N
	<i>unilobatus</i>	Brunner von Wattenwyl		B	—	S
	<i>applicatus</i>	Brunner von Wattenwyl		B	—	S, C
	<i>speciosus</i>	Brunner von Wattenwyl		B	—	S
	<i>mutator</i>	Ramme		B	—	N
	<i>sororum</i>	Ramme		B	—	C
	<i>lineatus</i>	Ramme		B	—	C
	<i>guttulosus</i>	Ramme		B	—	N
Acrolophus	<i>cornutus</i>	Ramme		B	—	C
Alectorolophellus	<i>heinrichi</i>	Ramme		B	—	S
Mengkokacris	<i>olivacea</i>	Ramme		W?	—	SE
Heinrichius	<i>nobilis</i>	Ramme		W	—	N
Celebesia	<i>acuticerca</i>	Bolivar C	+	W?	—	N
	<i>ferruginata</i>	Brunner von Wattenwyl		W?	—	N
	<i>heinrichi</i>	Ramme		W?	—	S
Paramesambria	<i>flavomaculata</i>	Willemse		B	—	S
Paracranae	<i>celebesia</i>	Willemse	+	B	—	N
Catantopinae – Non-endemic genera						
Tarbaleus	Brunner von Wattenwyl				M, NG	
Oxya	sp. n.		+	B	—	N
	<i>japonica</i>	<i>japonica</i> Thunberg	+	W	Across S, P	All
	<i>bolaangensis</i>	Hollis		W	—	N
	<i>stremannii</i>	Ramme		W	—	C
Gesonula	<i>mundata</i>	<i>pulchra</i> Rehn	+	W	Across S	N
Chitaura	<i>brachyptera</i>	Bolivar I	+	B	—	N
	<i>flavolineata</i>	(Willemse)		B	—	N
	<i>atrata</i>	Ramme		B	—	C
	<i>mirabilis</i>	Carl		B	—	C
	<i>ochracea</i>	Ramme		B	—	S
	<i>vidua</i>	Carl		B	M	S
	<i>mengkoka</i>	Ramme		B	—	SE
	<i>samanga</i>	Carl		B	—	S, SE, C
	<i>poecila</i>	Ramme		B	—	N
	<i>elegans</i>	Ramme		B	—	S

Table 1. Species of Acridoidea occurring in Sulawesi and their distributions. (continued).

			Wings ¹	Distribution ²	
				Outside	Within
<i>Oxytauchira</i>	<i>gracilis</i> Willemse		W	Burma	
<i>Stenocatantops</i>			—	C	*
	<i>splendens</i> Thunberg	+	W	Across	
	<i>angustifrons</i> Walker		W	Across	all
<i>Bibracte</i> Stål	sp. n.	+	B	Across	S
			—	S, M, P	
<i>Valanga</i>	<i>transiens</i> Walker	+	W	—	N
			—	Across	
<i>Oxyrrhepes</i>	<i>meyeri</i> Willemse		W	S	?
	<i>obtusa</i> de Haan		W	S	N, C
<i>Cranaella</i>	<i>carnipes</i> Ramme		P		
<i>Tristria</i>	<i>pisciforme</i> Serville		S		
<i>Austracris</i>	<i>guttulosa</i> <i>guttulosa</i> Walker		S		
<i>Mesambria</i>	<i>maculipes</i> Stål	+	W	P, A	
	<i>elegans</i> Ramme		—	A	N
	<i>trapezina</i> Ramme		—	India?	
	<i>rectangularis</i> Ramme		—	all	
<i>Traulia</i>	<i>kukenthali</i> Ramme		—	S	
	<i>sanguinipes</i> Stål		—	C	*
<i>Apalacris</i>			—	N	*
	<i>gracilis</i> Willemse		W?	S, P, M	
	<i>incompleta</i> Willemse		W?	?	*
	<i>celebensis</i> Willemse		S	?	
<i>Moessonia</i>	<i>tenebrifera</i> Walker		—	S, P	
			—	S	
			—	S	
			—	?	*
			—	NG	
			—	—	N

Notes

+ indicates a species collected by Project Wallace

1 - W - fully winged

W? - winged but probably a poor flier

B - brachypterous or wingless

2 - Distributions outside Sulawesi:

M - Moluccas

S - Sundaland

P - Philippines

A - Australasia

NG - New Guinea

Across - at least Sundaland to New Guinea

2 - Distributions within Sulawesi:

all - all four regions

N - North

S - South

SE - South-East

C - Central

* indicates that the species is known only from one or a few sites.

are reasonably reliable since intensive collecting produced so few undescribed species, and those only from inaccessible habitats. Data on distribution within Sulawesi is less reliable with a significant proportion of species described from only one or a few localities. However collecting localities in the past have been widespread and so this may reflect very localised species distributions (see below). A probable exception is Central Sulawesi, parts of which remain very inaccessible. The expedition collection represents only a small proportion of the total acridoid fauna of Sulawesi (16 out of 59 described species) and this is also likely to be a result

of localised species distributions rather than under-collecting.

The acridoid fauna of Sulawesi

Expedition and literature data give a total of 62 Sulawesi acridoid species in 33 genera and five subfamilies (table 1). The Catantopinae form by far the largest group with 53 species. This very diverse subfamily, which some authors consider to be an amalgam of several distinct subfamilies (eg Dirsh 1961), is one of the few acridoid groups to have adapted to forest environments. All of the non-

catantopine species in Sulawesi are forest edge or open habitat species whereas about 80% of catantopine species occupy habitats within the forest. Related to this is the occurrence of flightless species, with wings either absent or reduced, which are much more common in the Catantopinae (37/53 species) than in the other subfamilies (1/9 species). Flightlessness in grasshoppers is probably an adaptation to poor habitat quality, diversion of resources away from wing and flight muscle production allowing earlier reproduction and/or greater fecundity (Ritchie et al. 1987), and is common in forest species in other areas (Jago 1973).

Flightlessness clearly limits dispersal and so may have an impact on levels of endemism. In Sulawesi endemism is high for the Acridoidea, as it is for many other groups (Whitten et al. 1987) including Eumastacidae and Tetrigidae in the Orthoptera (Butlin et al 1989, Blackith & Blackith 1988). Overall 74% of acridoid species are endemic to Sulawesi but the proportion is higher in the Catantopinae (83%) than in the other subfamilies (22%). There is a clear link with the ability to fly: only two out of nine non-endemic catantopines are flightless, and the one flightless non-catantopine is endemic (table 1).

Table 2. Comparison of the Catantopinae of Sulawesi and Java.

	Java	Sulawesi
Number of species recorded	47	53
Number of genera recorded	34	24
Number of species per genus	1.38	2.21
Proportion of endemics – species	40%	83%
– genera	15%	33%

Table 3. Distributions outside Sulawesi.

	Non-endemic Species ¹	Non-endemic Genera ²	Relationships of Endemic Genera ³
Across	5	1 (10)	0
Sunda Shelf	7	4 (8)	2
Borneo (exclusively)	0	0 (0)	1
Philippines (exclusively)	1	1 (1)	0
Moluccas (exclusively)	1	0 (0)	0
Australasia	1	2 (3)	1

Notes

- Includes distributions of *Oxya japonaci japonaci*, *Genesula mundata pulchra*, and *Austracris guttulosa guttulosa*. All species have distributions 'Across' but the subspecies have informative distributions.
- Excluding (including) genera with non-endemic species.
- See text for details.

The special nature of the Sulawesi fauna can be appreciated better if it is compared with the fauna of Java. Java is the most comparable island in the region in terms of land area (126,500 km²) but is part of the Sunda Shelf and has a clearly Oriental fauna. This comparison can be made most easily for the Catantopinae using data from C. Willemse (1956, 1957), F. Willemse (1965) and Hollis (1971, 1975). The total number of species recorded is similar (table 2) but the number of genera present in Sulawesi is lower with a significantly greater number of species per genus ($\chi^2 = 6.5$ P < 0.01). Endemism at the species level in Sulawesi is twice that in Java, as is generic level endemism.

Biogeographical links

Sharing of taxa between Sulawesi and its surrounding areas is summarised in table 3 for non-endemic species (and subspecies) and genera. It is clear that Sulawesi shares the greatest number of species and genera with the Sunda Shelf as a whole (Peninsula Malaysia, Borneo, Sumatra, Java and Bali). This bias is strongest at the specific level but is also present among non-endemic genera. We have found no exclusive links with Borneo at either level, despite the close proximity of the two islands.

Links with the Philippines are mostly due to species or genera which also occur on the Sunda Shelf but there are two exclusive links, the gomphocerine *Eoscyllina luzonica* and the catantopine genus *Cranaella*. No species shared between Sulawesi and the Lesser Sunda Islands have been identified. To the east there is one species, *Chitaura vidua*, which occurs in Sulawesi and the Moluccas and one, *Austracris guttulosa*, which is distributed widely in Australasia and for which Sulawesi is the western limit. At the generic level there are two further links to the east, the genera *Moessonia* and *Tarbaleus*.

For endemic genera biogeographical information can only be derived from the distribution of sister genera but since the phylogeny of these groups has been studied very little these relationships are not known with any certainty. The following relationships, suggested by Ramme (1941) and Willemse (1951, 1956, 1957), are included in table 3. A group of four endemic genera, the Acrolophi (*Acrolophus*, *Alectorolophus*, *Alectorolophellus* and *Mengkokacris*), has apparently evolved within Sulawesi, indicating a long period of isolation. The nearest relatives of this generic group are apparently *Paralectrolophus* and *Lyrolophus* which occur on Lombok and Java respectively. The acridine genera *Calliphlaeoba* and *Phlaebacris* are both probably related to *Phlaeoba* which has a Sunda Shelf plus Philippines distribution.

Heinrichius is believed to be most closely related to *Nolibia* and therefore provides the only exclusive

link with Borneo. *Paracranae* is part of the *Cranae* group of genera which occurs in the Moluccas and New Guinea (Willemse 1977a, b).

Two genera are problematic because their nearest relatives are non-endemic Sulawesi genera. This implies that the latter are polyphyletic since the Sulawesi representatives of the two genera of each pair are likely to be more closely related to one another than the Sulawesi species of the non-endemic genus are to species in the same genus occurring elsewhere. *Celebesia* is believed to be most closely related to *Traulia* (Sulawesi and the Sunda Shelf), an *Paramesambria* to *Mesambria* (Sulawesi and India, Henry 1942). The distribution of *Mesambria* is particularly surprising but it is paralleled by *Chitaura* which also has an Indian representative (Hollis 1975). Neither of the two endemic genera (*Celebesia* and *Paramesambria*) has been included in table 3.

Endemism within Sulawesi

Mosaic distributions of species or subspecies within Sulawesi have been noted for several animal groups, eg macaques, carpenter bees, pond skaters (Whitten et al 1987 and see Knight & Holloway 1990). Ramme (1941) commented on a similar phenomenon in the Catantopinae and this appears quite striking when the island is divided into regions (table 4). A high proportion of the species present in any one region are known only from that region. This is particularly clear in the two most species rich genera in Sulawesi: *Alectorolophus* has nine species, seven of which are known from only one region, and *Chitaura* has ten species, nine of which are known from only one region. However the distributional information available is limited. Many species (table 1) are known from only one locality, but collecting localities overall have been widely distributed around the island and so this may represent genuinely very restricted distributions. Where more localities are known, five out of seven endemic and six out of eight non-endemic species are restricted to one region. Intensive searching of a restricted area during the Project Wallace expedition yielded only a small proportion of the total number of catantopine species known to occur in

Sulawesi (10/53) but a much higher proportion of the species known to occur in North Sulawesi (9/21). Only one species previously reported from another region was collected. Nine of the species not collected on the expedition were previously reported only from the western part of the peninsula of North Sulawesi, (particularly Toli-Toli) distant from the Dumoga-Bone National Park, suggesting that distributions are also restricted within regions. The within island endemism in the genus *Chitaura* is particularly striking in this context. Species in this genus are brightly coloured and conspicuous and occur on the forest edges as well as in light gaps within the forest. It is unlikely that the expedition would have failed to collect any species occurring in the Dumoga Bone area and yet only one of the ten Sulawesi species was found. This argument applies to collecting of *Chitaura* in general and so this genus gives strong support to the existence of intra-island endemism, and would be a good candidate for further work.

DISCUSSION

The Acrididae of Sulawesi show four main characteristics: (a) a high level of endemism, (b) low generic diversity but a high number of species per genus, (c) diverse distributions outside Sulawesi, and (d) localised species distributions within the island. These features have parallels in several other animal groups (Whitten et al 1987, Knight & Holloway 1989) and can be related to the geological history of the island.

The Acridoidea did not begin their radiation until the mid-Tertiary (Sharov 1968), that is after the break up of Gondwanaland and the beginning of the proposed northward movements of the fragments of present day Sulawesi. Thus the current Acridoid fauna of Sulawesi must have originated by dispersal and its low generic diversity can be explained in one of two ways: either Sulawesi was more isolated for much of its history than it is at present, or it has only recently become dry land due to tectonic uplift. The former explanation is more consistent with the observation of high levels of specific and generic endemism and high numbers of species per genus on the island, all of which suggest a long period of independent evolution for the Sulawesi acridooids. The sources of colonists for Sulawesi appear to have been numerous although the largest number of shared species and genera is clearly with the Sunda Shelf region. This may be partly due to the higher diversity of Acridoidea in Asia than in Australasia but there are several species or subspecies distributions which extend eastwards only as far as Sulawesi and very few equivalent Australasian distributions which extend westwards to Sulawesi. Thus at least a part of Sulawesi appears to have been closer to the Sunda Shelf than to Australasia for a significant

Table 4. Regional distribution of Catantopine species within Sulawesi.

Region	Number of species occurring in:	
	that region only	that region and elsewhere
North	19	5
Central	8	6
South	12	5
South-East	3	5

part of its history. However its current proximity to Borneo is probably recent since there are no exclusive biogeographical links at the level of shared species or genera. This is also true in other animal groups, notably the butterflies (Vane-Wright 1990). Exclusive links with the Philippines and Moluccas are also weak and may be recent. This is consistent with a general geological view of the area as a collision zone in which the area of dry land is increasing and land masses are moving closer together.

The high proportion of endemic species and genera in Sulawesi, the number of species per genus, and the evidence for evolution of new genera within the island all suggest not only a long period of isolation but also the opportunity for considerable evolutionary change and speciation. The mosaic distributions of species, particularly in the forest dwelling, flightless catantopines, may provide a clue to the conditions which have favoured these developments. Mosaic distributions are a feature of several other animal groups (Whitten et al 1987, Knight & Holloway 1990) and the patterns in different groups appear to be broadly coincident, defining areas of endemism within Sulawesi. The simplest explanation for these areas of endemism is past fragmentation of Sulawesi. This could have been in the form of an archipelago at times of higher sea level or before tectonic uplift and volcanic activity had created the present land mass (Musser 1987), or due to reduction in the extent of forest habitats in periods of drier climate (Morley & Flenley 1987). The wingless, forest adapted catantopines would be particularly susceptible to population fragmentation by such processes. Evolutionary divergence on islands or in refugia would have been followed by expansion to form the present mosaic distribution. Contact zones between the forms have not been studied, or indeed accurately located, and so the consequences of renewed contact are unknown. In general several possible types of interaction exist: sufficiently divergent forms may be able to spread into sympatry progressively obscuring the mosaic pattern, less divergent forms may interact at sharp parapatric boundaries due to ecological exclusion, or where reproductive isolation is incomplete a hybrid zone may form (Barton & Hewitt 1985). Identification and analysis of such contact zones is likely to be a very productive area for future research.

Strict isolation on islands or in refugia may not be necessary for evolutionary divergence (Barton 1989), especially in an island with the curious shape of Sulawesi in which gene flow between populations inhabiting different peninsulas would be extremely restricted even if they were connected by continuous suitable habitat. However, divergence without isolation is likely to produce different patterns of variation for individual characters within

species as well as for different species. Coincidences of patterns of variation are most likely to be produced by contraction and expansion of populations, and this process may be necessary for the completion of speciation (Hewitt 1989).

The mosaic distributions of species within Sulawesi constitute evidence either for the archipelagic nature of the land mass in the past or for habitat fragmentation during climatic fluctuations, or both. The time scale for these changes, and thus for the evolution of the Sulawesi endemics, is uncertain. They could have occurred mainly in the Pleistocene or over a much longer time scale of the order of the 15 Myrs suggested as the time since the formation of Sulawesi as a single unit (Audley-Charles 1987). Most probably the present fauna of Sulawesi is the result of several superimposed periods of divergence. Studies of genetic divergence and detailed investigations of the contact zones appear to be the way forward in understanding the evolution of the Sulawesi grasshoppers.

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REFERENCES

- Audley-Charles, M. G., 1987. Dispersal of Gondwanaland: relevance to evolution of the angiosperms. – In: Biogeographical evolution of the Malay archipelago, ed. by T. C. Whitmore, pp. 5-25. Clarendon Press, Oxford.
- Barton, N. H., 1989. Speciation. – In: Analytical Biogeography, ed. by A. A. Myers & P. S. Giller, pp. 185-218. Chapman and Hall, London.
- Barton, N. H. & G. M. Hewitt, 1985. Analysis of hybrid zones. – Annual Review of Ecology and Systematics 16: 113-148.
- Blackith, R. E. & R. M. Blackith, 1988. Tridactyloids and tetrigids (Orthoptera) from Sulawesi, Indonesia. – Tijdschrift voor Entomologie 130: 1-10.
- Butlin, R. K., R. E. Blackith & R. M. Blackith, 1989. Eumastacidae (Orthoptera) from the Project Wallace expedition to Sulawesi, Indonesia. – Tijdschrift voor Entomologie 132: 109-113.

Charlton, T. R., 1986. A plate tectonic model of the eastern Indonesia collision zone. – *Nature* 319: 394-396.

Dickerson, R. E., E. D. Merrill, R. C. McGregor, W. Schultze, E. H. Taylor & A. W. C. T. Herre, 1928. Distribution of life in the Philippines. – *Philippine Journal of Science* 21: 1-322.

Dirsh, V. M., 1954. Revision of the genus *Acrida* L. – *Bulletin de la Société Fouad I^{er} d'Entomologie* 38: 107-160.

Dirsh, V. M., 1961. A preliminary revision of the families and subfamilies of Acridoidea (Orthoptera: Insecta). – *Bulletin of the British Museum (Natural History), Entomology* 10: 352-419.

George, W., 1987. Complex origins. – In: Biogeographical evolution of the Malay archipelago, ed. by T. C. Whitmore, pp. 119-131. Clarendon Press, Oxford.

Henry, G. M., 1942. Three remarkable stridulatory mechanisms in Acrididae (Orthoptera). – *Proceedings of the Royal Entomological Society (Series A)* 17: 59-62.

Hewitt, G. M., 1989. The subdivision of species by hybrid zones. – In: Speciation and its Consequences, ed. by D. Otte & J. A. Endler, pp. 85-110. Sinauer Associates, Sunderland, Massachusetts.

Hollis, D., 1968. A revision of the genus *Aiolopus* Fieber (Orthoptera: Acrididae). – *Bulletin of the British Museum (Natural History), Entomology* 22: 309-355.

Hollis, D., 1971. A preliminary revision of the genus *Oxya* Audinet-Serville (Orthoptera: Acridoidea). – *Bulletin of the British Museum (Natural History), Entomology* 26: 267-343.

Hollis, D., 1975. A review of the subfamily Oxyinae (Orthoptera: Acridoidea). – *Bulletin of the British Museum (Natural History), Entomology* 31: 189-234.

Holloway, J. D., 1987. Lepidoptera patterns involving Sulawesi: what do they indicate of past geography? – In: Biogeographical evolution of the Malay archipelago, ed. by T. C. Whitmore, pp. 103-118. Clarendon Press, Oxford.

Jago, N. D., 1973. The genesis and nature of tropical forest and savannah grasshopper faunas, with special reference to Africa. – In: Tropical forest ecosystems in Africa and South America: A comparative review, ed. by B. J. Meyers, E. S. Ayensu and D. Duckworth, pp. 187-196. Smithsonian Institution Press, Washington.

Kevan, D. K. McE. & Y-K Chen, 1969. A revised synopsis of the genus *Actatomorpha* Saussure 1862 (Orthoptera; Pyrgomorphidae) with an account of the African *aberrans* group. – *Zoological Journal of the Linnean Society* 48: 141-198.

Knight, W. J. & J. D. Holloway, (eds.) 1990. Insects and the rainforests of Southeast Asia (Wallacea). Royal Entomological Society of London Symposium, in press.

Morley, R. & J. R. Flenley, 1987. Late Cainozoic vegetational and environmental changes in the Malay archipelago. – In: Biogeographical evolution of the Malay archipelago, ed. by T. C. Whitmore, pp. 50-59. Clarendon Press, Oxford.

Musser, G. G., 1987. The mammals of Sulawesi. – In: Biogeographical evolution of the Malay archipelago, ed. by T. C. Whitmore, pp. 73-93. Clarendon Press, Oxford.

Ramme, W., 1941. Beiträge zur Kenntnis der Acrididen-Fauna des indomalayischen und benachbarter Gebiete (Orth.). – *Mitteilungen aus dem Zoologischen Museum in Berlin* 25: 1-219.

Ritchie, J. M., 1982. Revision of *Gastrimargus*. – *Bulletin of the British Museum (Natural History), Entomology* 44: 239-329.

Ritchie, M. G., R. K. Butlin & G. M. Hewitt, 1987. Causation, fitness effects and morphology of macropteryism in *Chorthippus parallelus* (Orthoptera; Acrididae). – *Ecological Entomology* 12: 209-218.

Sharov, A. G., 1968. Phylogeny of Orthopteroïd insects. – Academy of Sciences of the U.S.S.R. (Moscow) Proceedings of the Paleontological Institute 18: 1-216.

Steenis, C. G. G. J. van., 1979. Plant geography of east Malesia. – *Botanical Journal of the Linnean Society* 79: 97-178.

Vane-Wright, R. I., 1990. The Philippines – Key to the biogeography of Wallacea. – In: Insects and the rain forests of Southeast Asia, ed. by W. J. Knight & J. D. Holloway. Royal Entomological Society of London Symposium, in press.

Walker, D., 1982. Speculations on the origin and evolution of Sunda-Sahul rain forests. – In: Biological diversification in the tropics, ed. by G. T. Prance, pp. 554-575. Columbia University Press, New York.

Wallace, A. R., 1869. The Malay archipelago. MacMillan & Co, London.

Whitmore, T. C., 1984. Tropical rain forests of the Far East. 2nd ed. Clarendon Press, Oxford.

Whitten, A. J., M. Mustafa & G. S. Henderson, 1987. The ecology of Sulawesi. Gadjah Mada University Press, Indonesia.

Willemse, C., 1951. Synopsis of the Acridoidea of the Indo-Malayan and adjacent regions. Part I. Fam. Acrididae, subfam. Acridinae. – *Publikaties Natuurhistorisch Genootschap in Limburg* 4: 41-114.

Willemse, C., 1956. Synopsis of the Acridoidea of the Indo-Malayan and adjacent regions. Part II. Fam. Acrididae, subfam. Catantopinae, part I. – *Publikaties Natuurhistorisch Genootschap in Limburg* 8: 3-225.

Willemse, C., 1957. Synopsis of the Acridoidea of the Indo-Malayan and adjacent regions. Part III. Fam. Acrididae, subfam. Catantopinae, part III. – *Publikaties Natuurhistorisch Genootschap in Limburg* 10: 227-500.

Willemse, F., 1965. Acridoidea chiefly from Java in the Zoologisches Staatsinstitut und Zoologisches Museum of Hamburg. – *Entomologische Mitteilungen Zoologischen Museum Hamburg* 3: 53-67.

Willemse, F., 1968. Revision of the genera *Stenocatantops* and *Xenocatantops* (Orthoptera: Acrididae: Catantopinae). – *Monografieën van de Nederlandse Entomologische Vereniging* 4: 5-77.

Willemse, F., 1977a. A study on the genus *Cranae* Stall (Orthoptera, Acridoidea, Catantopinae). – *Tijdschrift voor Entomologie* 120: 121-152.

Willemse, F., 1977b. A study on the genus *Cranaella* Ramme (Orthoptera, Acridoidea, Catantopinae). – *Tijdschrift voor Entomologie* 120: 121-152.

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TWO NEW SPECIES OF *SARCOPHAGA* MEIGEN FROM MADEIRA AND MAINLAND PORTUGAL (DIPTERA: SARCOPHAGIDAE)

Pape, T., 1990. Two new species of *Sarcophaga* Meigen from Madeira and mainland Portugal (Diptera: Sarcophagidae). — Tijdschrift voor Entomologie 133: 39-42, figs. 1-9. [ISSN 0040-7496]. Published 31 July 1990.

Sarcophaga (Discachaeta) amputata sp.n. (Madeira) and *Sarcophaga (Pierretia) iulicina* sp.n. (Portugal) are described and their phylogenetic affinities are discussed. *S. iulicina* was bred from the millipede *Ommatoiulus moreleti* (Lucas, 1860).

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Key words. — Diptera; Sarcophagidae; New species; Madeira; Portugal.

INTRODUCTION

A number of specimens representing two undescribed species of *Sarcophaga* Meigen were recovered from various sources. As the accompanying biogeographical and biological information is rather interesting, it is felt that the following descriptions are justified, although they do not form part of a more thorough revision.

Depositories for specimens examined are indicated by the following acronyms:

BMNH – British Museum (Natural History), London, England; NMWC – National Museum of Wales, Cardiff, England; ZMUC – Zoologisk Museum, University of Copenhagen, Denmark.

SYSTEMATIC PART

Sarcophaga (Discachaeta) amputata sp.n. (figs. 1-4)

Type material. — Holotype ♂, Madeira (Portugal): Between Canical & Prainha, 5.viii.1981, M. Jones (NMWC). The holotype is in good condition, glued to the pin along the right side of thorax and with the terminalia dissected and glued to a piece of cardboard pinned with the specimen.

Paratypes. Madeira: 1♂ 1♀, [no further locality, but with the number 1948-301], T.W. Wollaston (BMNH, NMWC); 2♀, data as holotype (NMWC, ZMUC); North end of Deserta Grande, 1♂ 1♀, 18.viii.1981, M. Jones (ZMUC, NMWC).

Description

Male. — Head. Narrowest part of frons 0.25-0.30 × head width. Parafacial plate with a uniserial row of setae along the eyemargin, the lower setae of this row being long and bristly. Postgena with white setae in about posterior 0.50-0.75

(strict lateral view).

Thorax. Proanepisternum setose in about upper half. Chaetotaxy: 3 indistinct pairs of presutural acrostichals, postsutural acrostichals absent or represented by the prescutellar pair only, dorsocentrals = 3 + 3, intra-alars = 1 + 2, supra-alars = 1 + 3, post alars = 2. Scutellum with a pair of apicals, 3-4 pairs of marginals and without discals. Mid femur with 2-3 anteroventral bristles, no posteroventral bristles. Hind tibia with a sparse row of elongated posteroventral setae.

Abdomen. Tergites 3-4 with silvery grey microtomentum mainly restricted to anterior half and almost non-changing; interrupted by a median black stripe. Tergite 5 with microtomentum reduced to narrow strips in antero-lateral position. Terminalia black or blackish brown. Protandrial segment with a row of marginal bristles. Cercus in profile with a distinct subapical dorsal hump. Aedeagus with very long harpes that terminates in a distinct hook, and a long, terminally bifid juxta. Gonopod with the usual row of long setae along dorsal margin but with some additional setae on the median surface.

Length: 8-9 mm (estimated from dissected specimens).

Female. — Very like the male apart from the usual sexual dimorphism. Abdominal pattern slightly more changing and with the median black stripe almost absent. Mid femoral organ not differentiated. Terminalia red. Tergite 6 broadly arched, the dorsal part reduced to a narrow strip, and marginal bristles only present laterally.

Length: 7.0-7.5 mm.

Distribution. — Palaearctic: Madeira islands (Madeira, Deserta Grande).

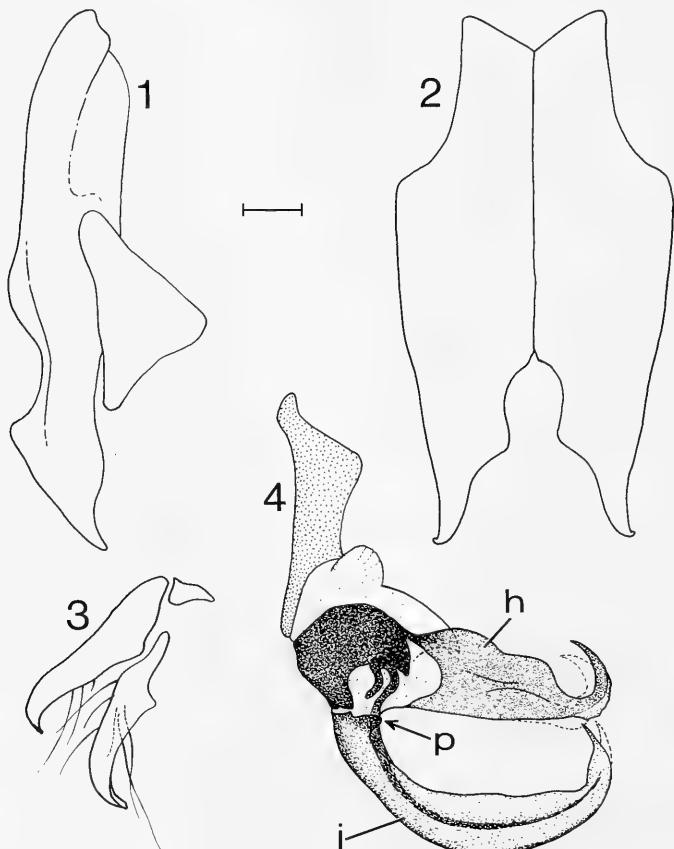
Etymology. — A Latin adjective, *amputatus* = cut off, amputated. The name refers to the structure of the aedeagus where the pair of very short arms at juxtal base will separate the species from all other species of the subgenus *Discachaeta*.

Remarks. — The sarcophagid fauna of Madeira was reviewed by Pape (1986), who listed a total of five species, three of which were judged to be recent introductions by man. The present species is interesting as it is the third apparently endemic species, and much evidence is in favour of considering this the sister species of the Madeiran *Sarcophaga* (*Discachaeta*) *kunonis* (Pape, 1986). The latter species was described in the genus *Discachaeta* Enderlein, which here is given subgeneric rank following the wide concept of *Sarcophaga* employed by Séguin (1941), Downes (1965) and Pape (1988). *Discachaeta* is probably a monophyletic group, this hypothesis being corroborated by at least the following character states that all seem to be derived with

regard to the groundplan of the Sarcophaginae and probably with regard to that of *Sarcophaga* sensu lato as well: 1) Male hind coxa with a ventro-median pad of short spiny bristles; 2) Aedeagal juxta more or less dome-shaped and arching over the lateral styli; 3) Base of juxta with a pair of arms or processes; 4) Male cercus dorsally with a flattened or concave area and with a more or less distinct hump subapically; 5) Female mid femoral organ, if present, in apical position.

Defined in this way, *Discachaeta* contains six species, all distributed in the western Palaearctic. (Note that the species *Discachaeta gigas* Povolný, 1986 was transferred to *Heteronychia* Brauer & Bergenstamm (*Eupierretia* Rohdendorf) in an addendum of the original paper.)

The hypothesis that *Sarcophaga amputata* and *S. kunonis* are sister species is corroborated by the presence in these two species of at least five character states that are judged to be derived with regard to the ground plan of *Discachaeta* and not found in any other species of this taxon: 1) Postgena with at least some black setae in anterior part, 2) Proanepisternum setose, 3) Abdominal tergite 5 almost de-



Figs. 1–4. *Sarcophaga amputata*, male terminalia. 1, right cercus and surstyli, lateral view, setae omitted; 2, cerci, posterior view, setae omitted; 3, right paramere + gonopod, lateral view; 4, aedeagus, lateral view. Abbreviations: h = harpes, j = juxta, p = process at juxtal base. Scale = 0.1 mm.

void of microtomentum, 4) Male gonopod with long setae on the median surface (fig. 3), and 5) Female mid femoral organ reduced, i.e. indistinct or absent. *Sarcophaga amputata* is easily separated from *S. kunoensis* in both sexes by the greater extension of white postgenal setae. These cover at least one half (strict lateral view) of the postgena in *S. amputata* while they are almost absent in *S. kunoensis*. However, as the Madeiran fauna of Sarcophagidae may still be incompletely known, the shape of the aedeagus still provides the best clue to reliable identifications.

Sarcophaga amputata may be widespread on the main island and is the first species of Sarcophagidae recorded from the Desertas islands.

Sarcophaga (Pierretia) iulicida sp.n. (figs. 5–9)

Type material. — Holotype ♂, Portugal: Mourão, ex *Ommatouulus moreletii*, larva 8.v.1987, pupa 14.v.1987, adult 30.v.1987, P.T. Bailey (BMNH). The holotype is in good condition, with the puparium glued to a piece of cardboard and the dissected terminalia stored in glycerine in a microvial, both items pinned with the specimen.

Description

Male. — Head. Narrowest part of frons 0.25 × head width. Parafacial plate with a row of setae along the eyemargin. The upper part of the row consists of uniserial setae, the lower part is irregularly biserial with 3–5 long bristles anterior to the

setae. Arista with longest hairs about 4 x as long as second aristomere. Gena with black setae only, postgena with white setae only.

Thorax. Proanepisternum bare. Chaetotaxy: 2–3 distinct pairs of presutural acrostichals, postsutural acrostichals (including prescutellars) not differentiated, dorsocentrals = 3 + 3, intra-alars = 1 + 2, supra-alars = 1 + 3, postalars = 2. Scutellum with 2 pairs of lateral scutellar bristles, 1 pair of short apicals, and 1 pair of discals. Mid femur with 3 anteroventral bristles and a row of posteroventrals. Apical posteroverntrals slightly stronger than apical anteroventrals. Hind tibia without elongated setae.

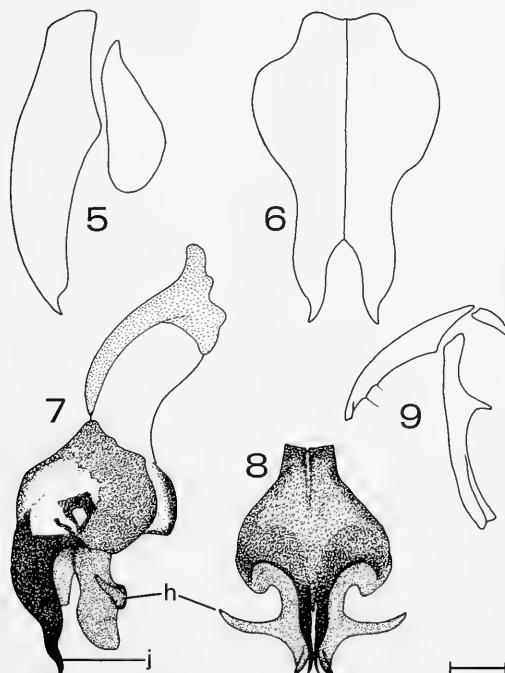
Abdomen. Tergites 3–4 with strong median marginals on T5 with a complete row of marginals. Terminalia black, protandrial segment without marginal bristles. Aedeagus with well developed harpes, each of which has a narrow winglike process that is directed laterally and opposite to its counterpart. Vesica reduced to a simple swelling or hump. Juxta moderately long and deeply cleft.

Length: 7 mm (estimated from dissected holotype).

Female. — Unknown.

Puparium of the usual barrel-shape and with the posterior spiracles in a deep pit as in most species of Sarcophaginae.

Distribution. — Palaearctic: Portugal.



Figs. 5–9. *Sarcophaga iulicida*, male terminalia. 5, right cercus and surstyli, lateral view, setae omitted; 6, cerci, posterior view, setae omitted; 7, aedeagus, lateral view; 8, distiphallus, dorsal (= posterior) view; 9, right paramere + gonopod, lateral view. Abbreviations: h = harpes, j = juxta. Scale = 0.1 mm.

Etymology. — A noun in apposition. From the Latin *iulus* = multiped, millipede, and *-cida* = suffix denoting cutter, killer, killing. The name refers to the millipede-parasitizing habit of the species.

Remarks. — The present species belongs to a probably monophyletic group whose members all possess an aedeagus very similar to that of *Sarcophaga nigriventris* Meigen. The group is defined by the characteristic and probably apomorphic shape of the aedeagal juxta, which can be dissolved into the two character states: 1) Juxta deeply cleft, and 2) Juxtal prongs tapering. Both states are readily seen on figs. 7–8. No formal genus-group name has been applied explicitly to this taxon, but the concept of *Pierretia* Robineau-Desvoidy (sensu stricto) of Verves (1986) is very close, the only difference being that this author includes *Sarcophaga granulata* Kramer, which does not possess either of the derived character states. I prefer to restrict the name *Pierretia*, as a subgenus of *Sarcophaga*, to the group of species possessing the two above mentioned character states, i.e. *Sarcophaga discifera*/Pandellé, *S. iulicida*, *S. lunigera* Böttcher, *S. nigriventris*, *S. socrus* Rondani, *S. soror* Rondani, *S. sororcula* (Rohdendorf) and *S. villeneuvei* Böttcher. *Sarcophaga iulicida* may easily be separated from other members of the subgenus by the wing-like projection of each of the harpes which is directed laterally and set at right angles to the longitudinal axis of the aedeagus. This is most easily seen in dorsal (= posterior) view (fig. 8).

The biology of *Sarcophaga iulicida* is interesting as very few Diptera are known to parasitise millipedes, and among the Sarcophagidae only species of the New World genus *Spiroboholomyia* Townsend have been repeatedly bred from live millipedes. The habits of other species of the subgenus *Pierretia* (as defined above) indicate a broad to very broad spec-

trum of hosts or prey. Thus, the species *Sarcophaga nigriventris* has been bred from snails, beetles, grasshoppers and bees (see references in Pape 1987).

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REFERENCES

- Downes, W. L., Jr., 1965. Family Sarcophagidae. Pp. 933–961. In: A. Stone et alii (eds): A catalog of the Diptera of America north of Mexico. – Agriculture Handbook No. 276, Washington, D.C.
- Pape, T., 1986. The Sarcophagidae (Diptera) of Madeira, with the description of a new species of *Discosphaeta* Enderlein. – Bocagiana 93: 1–4.
- Pape, T., 1987. The Sarcophagidae (Diptera) of Fennoscandia and Denmark. – Fauna entomologica scandinavica 19: 1–203, 2 pls.
- Pape, T., 1988. A revision of the Palaearctic Sarcophagidae (Diptera) described by C. Rondani. – Stuttgarter Beiträge zur Naturkunde (Serie A) 416: 1–22.
- Povolný, D., 1986. *Discosphaeta gigas* sp.n. und *Heteronychia* (*Heteronychia*) *vachai* sp.n. – zwei unbekannte Sarcophaginae-Arten aus dem Dinarischen Küstengebiet (Diptera, Sarcophagidae). – Acta Universitatis Agriculturae 34(2): 229–238.
- Séguy, E. 1941. Études sur les mouches parasites. 2. Calliphoridae, calliphorines (suite), sarcophagini et rhinophorines de l'Europe occidentale et méridionale. – Encyclopédie entomologique (A) 21: 1–436.
- Verves, Yu. G. 1986. Family Sarcophagidae. Pp. 58–193. In: A. Soós (ed.): Catalogue of Palaearctic Diptera. Vol. 12, Calliphoridae – Sarcophagidae. – Akadémiai Kiadó, Budapest.

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REVISIONARY NOTES ON AMERICAN SARCOPHAGINAE (DIPTERA: SARCOPHAGIDAE)

Pape, T., 1990. Revisionary notes on American Sarcophaginae (Diptera: Sarcophagidae). *Tijdschrift voor Entomologie* 133: 43-74, 66 figs. ISSN 0040-7496. Published 31 July 1990. Selected New World genera of Sarcophaginae are redefined: *Argoravinia* Townsend, 1917 is treated as a senior synonym of *Raviniopsis* Townsend, 1918, syn. n., *Comasarcophaga* Hall, 1931 as a senior synonym of *Archimimus* Reinhard, 1952, syn. n., and *Emblemasoma* Aldrich, 1916 as a senior synonym of *Pessoamyia* Lopes, 1938, syn. n. and *Colcondamyia* Reinhard, 1963, syn. n. *Microcerella* Macquart, 1851 is considered as synonymous to the tribe Microcerellini, except that *Cryptosarcophila* Townsend, 1931 is excluded, and 6 new names are proposed to replace junior secondary homonyms: *Microcerella aulacophyto* nom. nov. for *Aulacophyto auromaculata* Townsend, 1919; *Microcerella austrohartigia* nom. nov. for *Austrohartigia bicoloricauda* Lopes, 1981; *Microcerella boettcherimima* nom. nov. for *Boettcherimima hypopygialis* Lopes, 1950; *Microcerella boetia* nom. nov. for *Boettia ecuatoriana* Lopes, 1982; *Microcerella carchia* nom. nov. for *Carchia andina* Lopes, 1982; and *Microcerella jujuyia* nom. nov. for *Jujuyia alvarengai* Lopes, 1980. *Microcerella bermuda* sp. n. (Bermuda Is) and *M. adelpha* sp. n. (eastern Canada & USA) are described and the phylogenetic relationships to other members of the genus are discussed. *Microcerella acridiorum* (Weyenbergh, 1875) is considered a senior synonym of *Xenoppiella dyscineti* Blanchard, 1966, syn. n. *Fletcherimyia* Townsend, 1917 and *Spirobolomyia* Townsend, 1917 are discussed in a phylogenetic context and it is argued that both taxa should be excluded from *Blaesoxipha* (s.l.) [Protodexiini + Impariiini]. Species limits within the genera are revised and *Fletcherimyia abdita* sp. n. (southeastern USA) and *Spirobolomyia latissima* sp. n. (southeastern USA & Mexico) are described. *Tripanurga* Brauer & Bergenstamm, 1891 is redefined and treated as a senior synonym of *Metoposarcophaga* Townsend, 1917, syn. n. and *Eruophaga* Reinhard, 1963, syn. n. *Tripanurga guatemala* sp. n. (Guatemala) is described, and a probable sister group relationship to *T. villipes* (Wulp, 1895) is demonstrated. Infraspecific variation within *T. aurea* (Townsend, 1917) is discussed and the species is divided into a Baja Californian form and a mainland form.

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Key words. — Diptera; Sarcophagidae; generic redefinitions; new species; New World.

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INTRODUCTION

The New World fauna of Sarcophagidae deviates markedly from that of the Old World with regard to diversity. The subfamily Miltogrammatinae has significantly fewer species, which in part is to be expected as the fauna of the Palaearctic Region is much more fully known and the extension of generally species-rich areas as dry savannas, shrublands and semi-deserts is much larger, e.g. on the African mainland and in Central Asia. Within the subfamily Sarcophaginae, on the other hand, species richness *per se* is greater in the New World, and as the sarcophagine fauna of especially the neotropics, where the large majority of species occur, is still

very insufficiently known, this difference may become even more pronounced with time. The New World fauna of Sarcophaginae has diversified morphologically and biologically to a degree unrivalled by the Old World members of this subfamily. Some New World species have green eyes, several have a metallic abdomen, and variations in setosity and configuration of the male terminalia are legio and often much more radical than those of the Old World species. The New World species *Peckia gulo* and *Tricharaea occidua* represent the largest and the smallest species of Sarcophaginae, respectively, and sarcophagine life habits include parasites of millipedes and insects, as well as predators of reptile eggs, hymenopteran kleptoparasites and generalized scavengers. The much greater morphological and biological diversity of New World species of Sarcophaginae compared to those of the Old World has caused pronounced differences of opinion regarding generic limits within this subfamily (especially so, because many of the previous authors have been more interested in differences than in similarities). Numerous monotypic genera have been proposed, with no other warranty than their 'uniqueness' and/or weirdness.

My research on New World Sarcophaginae, especially in connection with a major conspectus of the genus *Blaesoxipha* covering species limits and inter- and infrageneric phylogenetic relationships (Pape in prep.), during a one-year fellowship at the National Museum of Natural History (USNM), Washington, D.C., has led me to propose some phylogenetically more consistent generic definitions. It is felt that these definitions, in addition to being theoretically sound, support identification and information retrieval purposes better, and it is considered appropriate to make the information available as a single paper, with descriptions of several hitherto unrecognized species which turned up during my study, rather than split it into several generic revisions and isolated descriptions of species. Thus, it should be stressed that the present paper is far from a comprehensive treatment of all New World genera, and the fact that most genus-group taxa have been excluded does not mean that these are accepted by me. Older genus-group taxa such as *Pachygraphia* Brauer & Bergenstamm, 1891, *Lepidodoxia* Brauer & Bergenstamm, 1891, and *Johnsonia* Coquillett, 1895 are especially in need of a critical revision and will probably have to be redefined as much broader entities in order to absorb the numerous 'less aberrant' and probably paraphyletic genera that often are considered 'closely related' to these genera. Much remains to be done before generic limits stabilize, and more thorough character analyses are needed before the taxa above species level can emerge as well corroborated monophyletic groups.

METHODS, TERMINOLOGY, DEPOSITORIES

Specimens were dissected by conventional cutting of terminalia and heating in potassium or sodium hydroxide for about five minutes with subsequent rinsing in distilled water and transfer through alcohol to glycerine. Drawings of terminalia were made from glycerine preparations, either directly by using an ocular grid or from semipermanent slide mounts in glycerine gel using a projecting compound microscope.

Names of genus-group and species-group taxa mentioned in the text are given without the conventional citing of the original author except where this has any direct bearing on nomenclature, e.g. in the lists of synonyms. According to the International Code on Zoological Nomenclature, authors do not form part of the name proper (ICZN: 51,a), and they often serve no other purpose than as a reference to the original source of the name. Recent revisions are usually a better authority on the identity of a species or genus than the original description. For the present paper, identities of taxa not explicitly defined are easily retrieved from the references cited in the associated discussion or from the most recent regional catalogues, i.e. Downes (1965) and Lopes (1969), but see also Shewell (1987).

Morphological terms follow McAlpine (1981) except that I have adopted Sabrosky's (1983) use of 'microtomentum' for the dense cuticular micro-pubescence that may give surfaces a pollinose or pruinose appearance.

As no generic cladogram of the Sarcophaginae has been produced in the present or any other paper I have made no attempt of evaluating transformation series polarities for the character states used in the generic diagnoses, i.e. whether apomorphic or plesiomorphic at the level in question (which would be nothing but 'qualified guesses' based on my own more or less explicitly developed ideas of generic phylogeny). The character states listed in the diagnoses are, of course, only a fraction of those known, and I have restricted the lists to contain only those states that seem to be unique (and therefore possibly autapomorphic) as well as states judged by me to possess 'diagnostic power' (i.e., they will in combination serve to define the taxon in question).

The institutions from which material examined or otherwise referred to is deposited have been abbreviated with the following acronyms:

- AMNH: American Museum of Natural History, New York, USA;
- CAS: California Academy of Sciences, San Francisco, USA;
- CNC: Canadian National Collection of Arthropods, Ottawa, Canada;
- FSCA: Florida State Collection of Arthropods, Gainesville, USA;

MACN: Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina;
 MCZ: Museum of Comparative Zoology, Cambridge, USA;
 MNHN: Museum National d'Histoire Naturelle, Paris, France;
 NMW: Naturhistorisches Museum Wien, Austria.
 UNAM: Instituto de Biología, Universidad Nacional Autónoma de México;
 USNM: National Museum of Natural History, Washington, D.C., USA;
 ZML: Zoologiska Museet, Zoologiska Institutionen, Lund, Sweden;
 ZMUC: Zoological Museum, University of Copenhagen, Denmark.

GENERIC REDEFINITIONS AND DESCRIPTIONS OF SPECIES

Genus Argoravinia

Argoravinia Townsend, 1917b: 190, 193, 195. Type species: *Sarcophaga argentea* Townsend, 1912 (= *Sarcophaga rufiventris* Wiedemann, 1830), by original designation.

Raviniopsis Townsend, 1918: 160. Type species: *Raviniopsis aurea* Townsend, 1918, by original designation.

Syn. n.

Sarcophagina Curran, 1928: 102. Type species: *Sarcophagina candida* Curran, 1928, by original designation.

Pachygraphomyia Hall, 1933: 259. Type species: *Pachygraphomyia spinosa* Hall, 1933, by original designation.

Diagnosis. — The genus *Argoravinia* may be defined by the following character states:

- 1) Aedeagus with a very long and S-shaped median stylus, see, e.g., Roback (1954: fig. 39);
- 2) One or more setae on the underside of the stem of r_{2+3} elongate;
- 3) Male cercal prong bent backwards;
- 3) Ejaculatory apodeme large.

As tentatively suggested by Pape (in press), the genera *Argoravinia* and *Raviniopsis* should be treated as synonyms. They have been included in a subtribe of their own (within Sarcodexiini) by Lopes (1975a, 1982e), the monophyly of which although never corroborated by explicit reference to probable apomorphies has never been questioned. Lopes (1982e) lists a number of character states, but only some of these can be considered derived with regard to the groundplan of the Sarcophaginae, and this author does not propose any most probable sister group. The two very distinctive character states 1-2 mentioned above seem to be autapomorphic and will fully define the genus. The remaining two character states may diagnose the taxon further, but these may be plesiomorphic at the level of *Argoravinia* (i.e. define a more inclusive group) as discussed under *Tripanurga*.

Having corroborated the monophyly of *Argoravinia*, it remains to be discussed why a splitting is opposed. One argument is the small size of this taxon, with a total of 7 species recognized at present. Even if monophyletic subgroups can be recognized (and in theory a complete resolution into dichotomies should be possible), nothing is gained by erecting formal genus-group names if one then has to create new family-group names (e.g. tribes and subtribes) to keep the related taxa together. Another, more formal, argument is the subgroups proper. *Argoravinia* in the narrow sense of Lopes (1976), including *A. rufiventris* and *A. alvarengai*, is most probably monophyletic, defined by the autapomorphic process from the posteroventral margin of the epandrium that partially covers the surstyli, and by the much more distinctly S-shaped median stylus compared to the remaining *Argoravinia* (see figs. in Lopes 1976 and 1988b). I have not found any character state shared only by these remaining species, which were treated as *Raviniopsis* by Lopes (1988b), that may be considered apomorphic at this level, and none have been suggested. If the monophyly of the taxon cannot be corroborated, it has to be either split or widened until fitting a pattern for which character state distributions corroborate a hypothesis of strict monophyly. In the present case, the obvious choice is a merging with the older *Argoravinia*.

Genus Comasarcophaga

Comasarcophaga Hall, 1931: 280. Type species: *Comasarcophaga texana* Hall, 1931, by original designation.

Tejasomyia Reinhard, 1945: 68. Type species: *Tejasomyia nexilis* Reinhard, 1945, by original designation.

Archimimus Reinhard, 1952: 140. Type species: *Archimimus camatus* Reinhard, 1952, by original designation.

Syn. n.

Diagnosis. — The genus *Comasarcophaga* may be defined by the following character states:

- 1) Male mid femur apically with a short comb-like row of posteroventral spines;
- 2) Male cercal prong bent backwards;
- 3) Aedeagal juxta slightly displaced ventrally relative to longitudinal axis of aedeagal tube, the latter thereby appearing 'hump-backed' (figs. 1-4, additional figs. in Lopes 1979 and Lopes & Tibana 1988);
- 4) Aedeagal vesica appearing more or less square in lateral view (cf. figs. mentioned above).

The genus *Comasarcophaga* was described by Hall (1931) as a monotypic genus for his new species *C. texana*. Downes (1965) synonymized *Comasarcophaga* with *Tejasomyia*, thereby adding the species *C. nexilis*, and apparently only these two species were included in the genus by Shewell (1987: 1168), who gave "2 spp.; Texas, California". Another species, *Sarcophaga prolepsis*, described

by Reinhard (1947) from Arizona, was transferred by Downes (1965) to *Blaesoxiphia* subgenus *Servisia*, and later by Lopes (1988d) to *Archimimus*. Lopes & Tibana (1988: 324) defined *Archimimus* in part by the features: "styli of glans and median process spinous" (lateral and median styli in my terminology) and "arista plumose to tip". However, by including *prolepsis* and *longispinus* (Lopes 1988d), which both possess simple lateral and median styli with small denticles as well as a pubescent or short-plumose arista with a distinctly bare tip, conditions perfectly like those found in most other Sarcophaginae, the definition breaks down at least for these characters. Other character states listed by Lopes & Tibana (1988) as diagnostic for *Archimimus* are: 3-4 post-dorsocentral bristles, proanepisternum bare, male mid femur with apical comb-like posteroventral spines, aedeagal vesica strongly sclerotized, and female tergite 8 (7 in my terminology) setose. These states, however, do not secure an unambiguous definition of the taxon as this combination is found in other genera, e.g. *Blaesoxiphia* in part and *Comasarcophaga*.

Of the four states listed in the definition above, 1 and 2 are found in several other genera. Only 3 and 4 seem to be unique (i.e. autapomorphic), but, unfortunately, they are less clear cut and more difficult to describe as are many other characters of the male terminalia. *Comasarcophaga* in the present definition may be divided into two groups based on similarity (as perceived by me) of the male terminalia: one containing *longispinus*, *nexilis*, *prolepsis* and *texana*; another containing the remaining members. This agrees with Lopes (1988d: 918), who mentioned that *longispinus* and *prolepsis* was "provisionally included in *Archimimus* in spite of some important differences from the type-species: last female sternite large and clypeal arch of the first instar larva complete". Differences as such, however, cannot reject phylogenetic relationships, and as I have found no better way to describe the species explicitly in terms of shared character states, lumping all *Archimimus* with *nexilis* and *texana* in a broader *Comasarcophaga* is necessary to maintain the monophony of the taxon.

Terminalia of species of *Comasarcophaga* not figured by Lopes (1979) and Lopes & Tibana (1988) have been illustrated in figs. 1-12.

The only biological information available for *Comasarcophaga* is a single breeding record of a male *C. texana* from the bulimulid snail *Rabdotus dealbatus*, and the fact that another male of this species has been collected from a dysentery fly trap (Neck & Lopes 1973).

Genus *Emblemasoma*

Emblemasoma Aldrich, 1916: 56. Type species: *Emblemasoma erro* Aldrich, 1916, by original designation.

Pessoamyia Lopes, 1938: 333. Type species: *Pessoamyia prosternalis* Lopes, 1938, by original designation. *Syn. n.*

Colcondamyia Reinhard, 1963a: 82. Type species: *Colcondamyia falcifera* Reinhard, 1963a, by original designation. *Syn. n.*

Golcondamyia Reinhard, 1963b: 152. Unjustified emendation of *Colcondamyia*.

Diagnosis. — The genus *Emblemasoma* may be defined by the following character states:

- 1) Prosternum broadened (Shewell 1987: fig. 28);
- 2) Male mid femur apically with a row of comb-like posteroventral spines.

When Lopes (1938) described *Pessoamyia* he did not present any hypothesis as to possible relationships to other genera, and the main reason for describing the genus apparently was the "prosternum extraordinariamente desenvolvido" (p. 333). Later, Lopes (1971b: 89) presented a "study of species showing large and inflated prosternum", although without commenting on the similarly equipped *Colcondamyia*, and he uncritically accepted the validity of the two genera discussed (i.e. *Emblemasoma* and *Pessoamyia*). Actually, he did not even mention whether or not he considered the enlarged prosternum as indicating phylogenetic relationship, but he later erected the subtribe *Emblemasomatina* (Lopes 1975b, as tribe in 1982e and 1988c), including all the above-mentioned genera (Lopes 1982e), and he explicitly recognized the modified prosternum to be autapomorphic within the Sarcophagidae (Lopes 1988c).

As shown in the list of synonyms given above, I prefer to reduce the (sub)tribe to the generic level, and at least three reasons should be considered. Firstly, the comparatively small size of the entire taxon (i.e. *Emblemasoma* in the present sense), does not, in my opinion, necessitate a generic subdivision to enhance the clarity of the phylogenetic relationships between the included species. Admittedly, a group consisting of *Pessoamyia* and *Emblemasoma* sensu Lopes (1988c) may probably be monophyletic based on the shared possession of a highly modified male cercus, which in profile has a subapical dorsal knob and ends in a blunt hook (Lopes 1988c: figs. 17, 42, 45), but I prefer to name this assemblage of species the *erro* species-group rather than use a formal genus-group name. Secondly, while the monophyly of *Emblemasoma* in the present sense seems reasonably well corroborated (the species are also biologically similar in being parasites or predators of insects, as far as known), the monophyly of the groups recognized by Lopes (1988c) seems much less corroborated. Thus, the only derived character states defining the taxon *Pessoamyia* seem to pertain to the aedeagus (vesica reduced, vesica spinous, 'lateral plates' hyaline, see key in Lopes 1975b), and Lopes (1988c: 17)

admitted that males are needed to decide whether species for which only females are known "belong to *Pessoamyia*, *Emblemasoma* or to a distinct genus". Thirdly, the enlarged prosternum provides an easy-to-see feature for the recognition of the taxon and thus of value from the point of view of the non-specialist (e.g. when using a generic key).

Note that Pape (1987) included *Emblemasoma auditrix* in a wide concept of *Blaesoxiphida*, and the bent male cercus and the fused abdominal sternites 6-8 of *auditrix* are indeed reminiscent of the condition found in some species of *Blaesoxiphida* (Soper et al. 1976). However, my revised concept of the latter genus (Pape in prep.) includes all sarcophagine species with the lateral styli non-conducting and fused ventrally through a median sclerotization (?vesica). Therefore, the three free and apparently sperm-conducting (i.e. hollow and communicating with the spermiduct) styli of *Emblemasoma* combined with the lack of a row of trochanteral spines provides evidence that neither *E. auditrix* nor all of *Emblemasoma* should be included in *Blaesoxiphida* (see also discussion under *Fletcherimyia* and *Spirobohomyia*). Evidence for either placement of *auditrix*, however, is rather sparse, and I prefer the present inclusion of this species in *Emblemasoma* mainly because an inclusion within *Blaesoxiphida* would require that the free styli should be considered a reversal, which so far has not been shown to occur in any other species of Sarcophaginae. A detailed numeric cladistic analysis of all sarcophagine genera is needed to test this hypothesis.

Genus Fletcherimyia

Fletcherimyia Townsend, 1917b: 191. Type species: *Sarcophaga fletcheri* Aldrich, 1916, by original designation.

Peltopyga Townsend, 1917b: 191, 194. Type species: *Sarcophaga celarata* Aldrich, 1916, by original designation.

Diagnosis. — The genus *Fletcherimyia* may be defined by the following character states:

- 1) Male mid femur apically with a short comb-like row of posteroventral spines;
- 2) Male cercal prong bent backwards;
- 3) Aedeagus with lateral styli shortened;
- 4) Aedeagal vesica a single tongue-shaped structure (figs. 13-18);
- 5) Aedeagal juxta with cuticular pubescence along the distal margin (figs. 13-18);
- 6) Female abdominal tergite 6 strongly convex;
- 7) Female abdominal sternites 6-7 fused;
- 8) Larvae unable to develop to maturity outside pitchers of *Sarracenia*.

Character states 5 and 6 seem to be autapomorphic.

Fletcherimyia and *Peltopyga*, both monotypic, were described in the same paper by Townsend

(1917b). When Townsend (1938) later redescribed these genera, he still included only the type species in *Peltopyga* while he did not state how many species were included in *Fletcherimyia*. Downes (1965) catalogued the Nearctic species and treated *Fletcherimyia* and *Peltopyga* as synonyms, including four similar species, all of which were known to deposit their larvae in pitchers of *Sarracenia*, in *Fletcherimyia* as subgenus of *Blaesoxiphida*.

This apparently obligate association with pitcher plants is reflected in the distribution in that all species of *Fletcherimyia* have their center of distribution in the eastern part of the continent. Buckell & Spencer (1957) listed *Sarcophaga fletcheri* from Canada (Robson, B.C.), but I have been unable to confirm this and the record was apparently not accepted by Downes (1965). Species of *Sarracenia* are mainly eastern in distribution although the most wide-ranging species, *S. purpurea*, reaches far west to the District of Mackenzie and the extreme northeastern part of British Columbia (Cody & Talbot 1973). *Sarracenia purpurea* is known from one locality only in B.C., a peat bog approximately 30 km south of Fort Nelson (Krajina 1968), and the record of *fletcheri* from Robson seems unlikely. It should be expected that species of *Fletcherimyia* require a certain density of *Sarracenia* localities to be able to maintain stable populations.

Males of *Fletcherimyia* can often be seen resting on the rim of the *Sarracenia* pitchers, and these may serve as the aggregation site. Females larviposit large first stage larvae singly into newly opened pitchers, and the larvae feed on invertebrates caught in the fluid. The larva lives submerged, but with the posterior end kept at the water surface to facilitate respiration. The mature larva leaves the pitcher and pupates at the base of the plant (Forsyth & Robertson 1975, Fish 1976, Fish & Hall 1978).

A few other species of Sarcophagidae breed in the pitchers of insectivorous plants: The Nearctic *Sarcophaga* (*Liosarcophaga*) *sarraceniae* in *Sarracenia* pitchers (Aldrich 1916) and the Oriental *Sarcophaga* (*Pierretia*) *urceola* in *Nepenthes* pitchers (Beaver 1979, Shinonaga & Beaver 1979), but these are easily shown by morphological evidence to have evolved the life habit independently from species of *Fletcherimyia*, and even from each other, as indicated by the subgeneric assignment given in parentheses.

Roback (1954) gave figures of the aedeagus of the four species known to him, but instead of straightening out the homologies of the acrophallid sclerotizations, he simply introduced the morphological term 'stematis' for the type of acrophallus found in *Fletcherimyia*. Lopes (1971a: 4) stated that "the opening [of the acrophallus] is very much complicated" and proposed that it had "a different origin" from that of *Blaesoxiphida*. This, however, seems

little warranted as there is no evidence that the sperm exit proper is not homologous throughout the Sarcophagidae (and probably all of Diptera), and therefore may serve as an important morphological landmark. If this is accepted, *Fletcherimyia* falls nicely within the groundplan pattern of the Sarcophaginae in that all species possess three styli which all seem to be more or less tubular and connected to the common sperm duct (fig. 18).

With the additional species described below, the genus contains five species, but some other species should be mentioned as they have been assigned to the genus *Fletcherimyia*. Lopes (1946) described *F. speciosa* from Mexico and included *Sarcophaga cesserator* as well, and Rohdendorf (1971) described *Fletcherimyia zayasi* from Cuba. These three species, however, all belong to *Blaesoxiphia*, the monophyly of which is corroborated mainly by the transformation of the lateral styli into non-conducting structures and a sclerotized ventromedian bridge connecting these (Pape unpubl.). It should be stressed that although Lopes (1971a: 5) stated that *Fletcherimyia* (and some other taxa) did "not belong to *Tephromyiini* [= the present *Blaesoxiphia* in part]" simply because they were "good genera", it is perfectly possible to argue for the inclusion of *Fletcherimyia* within *Blaesoxiphia*, e.g. as a subgenus (Downes 1965), simply by widening the concept of *Blaesoxiphia* sufficiently (e.g. by defining this genus on the comb-like pv bristles of the male mid femur). This does not, of course, alter the well corroborated hypothesis that species of *Fletcherimyia* as presently recognized, form a monophyletic group. My reason for not including *Fletcherimyia* within *Blaesoxiphia* is primarily that the resulting taxon, although possibly monophyletic if also containing *Comasarcophaga* and *Spiroboholomyia* discussed elsewhere in the present paper, would be much more vaguely defined in the sense that the monophyly would be much more tentative. Considering the well corroborated monophyly of *Blaesoxiphia*, *Comasarcophaga*, *Fletcherimyia* and *Spiroboholomyia* respectively, as well as their rather different external morphology, I see no convincing arguments for combining them into one taxon. It could be argued that the combined taxon would be more easy to identify in conventional sorting of specimens, as dissections of the male terminalia, which often are necessary for the non-specialist and therefore prevent handling a large number of specimens, would be reduced to a minimum. I still prefer, however, to give the criterion of monophyly higher priority than that of usefulness.

Fletcherimyia abdita sp. n. (figs. 13, 19, 24)

Type material. — Holotype ♂, USA: Alabama, Theodore, reared from *Sarracenia drummondii*, 10.vi.1916,

F.M. Jones [paratype of *Sarcophaga rileyi*, cf. Aldrich (1916: 243)] (USNM). Paratypes. — USA: 1♂, data as holotype but with the date 22.vi.1916 [paratype of *Sarcophaga rileyi*] (USNM); 2♂, locality as holotype but without date (FSCA, ZMUC); Florida, Freeport, 2♂, 25.vi.1921, [no collector, label in Jones' handwriting], reared from *Sarracenia drummondii* (FSCA); Mississippi, Biloxi, 1♂, 6.vi.1921, 2♂, 23.vi.1921, 2♂, 25.vi.1921, F.M. Jones, reared from *Sarracenia sledgei* (4 in FSCA, 1 in ZMUC).

Description

Male. — General morphology similar to other species of *Fletcherimyia* (see descriptions in Aldrich 1916), but separated from these by the structure of male abdominal sternite 5 and male terminalia (compare figs. 13-28). The following description is restricted to these diagnostic features.

Abdomen: Posterior margin of sternite 5 with accessory lobes like those of *F. celarata* but slightly raised from the plane of the remaining sternite so that a small flange penetrates behind (morphologically above) it (fig. 19). Sternite 5 of *F. celarata* has accessory lobes broadly rounded, level with remaining sternite (fig. 20), and dark brown along posterior margin in contrast to the yellowish remaining sternite. Sternite 5 of *F. rileyi* has tapering accessory lobes and posterior margin concolorous with remaining sternite (fig. 23).

Terminalia: Cercus, as seen in posterior view, with an outline intermediate between that of *F. fletcheri* and *F. rileyi*. The aedeagus is similar to that of *F. fletcheri*, but the juxta is broader and more square and the vesica is larger with a spinelike process at about middle (fig. 13).

Female. — Unknown.

Etymology. — A Latin adjective, from *abditus* = hidden, concealed, put away. The name refers to the fact that the holotype was found amongst paratypes of *F. rileyi*.

Distribution. — Nearctic: USA (Alabama, Florida, Mississippi).

Biology. — Larvae scavengers in pitchers of *Sarracenia drummondii* and *S. sledgei*.

Genus Microcerella

Microcerella Macquart, 1851: 209 (236). Type species: *Microcerella rufomaculata* Macquart, 1851, by original designation.

Doringia Weyenbergh, 1875: 85. Type species: *Nemorea acridiorum* Weyenbergh, 1875, by original designation.

Syn. n.

Euparaphyto Townsend, 1912: 359. Type species: *Euparaphyto alpina* Townsend, 1912, by original designation.

Syn. n.

Xenoppia Townsend, 1915: 20. Type species: *Xenoppia*

hypopygialis Townsend, 1915, by original designation. *Campptopyga* Aldrich, 1916: 41. Type species: *Campptopyga aristata* Aldrich, 1916 [= *Xenoppia hypopygialis* Townsend, 1915], by original designation.

Hypopelta Aldrich, 1916: 49. Type species: *Hypopelta scrofa* Aldrich, 1916, by original designation.

Aulacophyto Townsend, 1919: 158. Type species: *Aulacophyto auromaculata* Townsend, 1919 [secondary junior homonym of *Euparaphyto auromaculata* Townsend, 1919: 157] [= *Microcerella aulacophyto* nom. nov.], by original designation. *Syn. n.*

Gymnopsoa Townsend, 1919: 161. Type species: *Gymnopsoa texana* Townsend, 1919, by original designation.

Catheteronychia Townsend, 1927: 230. Type species: *Catheteronychia chaetosa* Townsend, 1927, by original designation. *Syn. n.*

Xanthobrachycoma Townsend, 1927: 232. Type species: *Xanthobrachycoma analis* Townsend, 1927, by original designation. *Syn. n.*

Townsendomyia Prado & Fonseca, 1932: 167. Type species: *Stephanostoma argenteum* Prado & Fonseca, 1932 [= *Sarcophaga (Bellieria) halli* Engel, 1931], by original designation. *Syn. n.*

Alaccoprosopa Townsend, 1934: 202. Type species: *Alaccoprosopa apicalis* Townsend, 1934, by original designation. *Syn. n.*

Austrohartigia Townsend, 1937a: 115. Type species: *Austrohartigia magellanica* Townsend, 1937a [= *Sarcophaga spinigena* Rondani, 1846], by original designation. *Syn. n.*

Microcerellamyia Hall, 1937: 354. Type species: *Microcerellamyia retusa* Hall, 1937, by original designation. *Syn. n.*

Itiophyto Hall, 1937: 355. Type species: *Itiophyto engeli* Hall, 1937, by original designation. *Syn. n.*

Mimophytomyia Hall, 1937: 357. Type species: *Mimophytomyia chilensis* Hall, 1937 [= *Alaccoprosopa apicalis* Townsend, 1934], by original designation.

Phaesarcodexia Hall, 1937: 362. Type species: *Phaesarcodexia aldrichi* Hall, 1937 (also as *Brachicoma aldrichi*) [= *Sarcophaga spinigena* Rondani, 1864], by original designation.

Eumicrocerella Hall, 1938: 253. Type species: *Eumicrocerella duca* Hall, 1938, by original designation. *Syn. n.*

Scopae-discus Blanchard, 1939: 802. Type species: *Scopae-discus muehni* Blanchard, 1939, by original designation. *Syn. n.*

Boettcherimima Lopes, 1950: 706. Type species: *Boettcherimima hypopygialis* Lopes, 1950 [secondary junior homonym of *Xenoppia hypopygialis* Townsend, 1915] [= *Microcerella boettcherimima* nom. nov.], by original designation. *Syn. n.*

Parahypopelta Blanchard, 1955: 30. Type species: *Parahypopelta salavini* Blanchard, 1955, by original designation. *Syn. n.*

Chapiniola Dodge, 1965: 253. Type species: *Chapiniola impressa* Dodge, 1965, by original designation. *Syn. n.*

Steatopyga Dodge, 1965: 254. Type species: *Steatopyga mirabilis* Dodge, 1965, by original designation. *Syn. n.*

Boetia Dodge, 1965: 255. Type species: *Boetia curiosa* Dodge, 1965, by original designation. *Syn. n.*

Xenopiella Blanchard, 1966: 182. Type species: *Xenopiella dyscineti* Blanchard, 1966 [= *Nemorea acridorum* Weyenbergh, 1875, syn. n.], by monotypy. *Syn. n.*

Azuayia Dodge, 1967: 681. Type species: *Azuayia tripartita* Dodge, 1967, by original designation. *Syn. n.*

Borgmeierisca Lopes, 1972: 349. Type species: *Borgmeier-*

isca pilicoxa Lopes, 1972, by original designation. *Syn. n.*

Townsendisca Lopes, 1974: 193. Type species: *Townsendisca matucanensis* Lopes, 1974, by original designation. *Syn. n.*

Xenoppina Lopes, 1975d: 573. Type species: *Xenoppina andina* Lopes 1975d, by original designation. *Syn. n.*

Aulacophytoides Lopes, 1978a: 765. Type species: *Aulacophytoides alvarengai* Lopes, 1978a, by original designation. *Syn. n.*

Jujuyia Lopes, 1980: 238. Type species: *Jujuyia alvarengai* Lopes, 1980 [secondary junior homonym of *Aulacophytoides alvarengai* Lopes, 1978a] [= *Microcerella jujuyia* nom. nov.], by original designation. *Syn. n.*

Mallochisca Lopes, 1982b: 364. Type species: *Mimophytomyia mallochi* Hall, 1937, by original designation. *Syn. n.*

Penaissa Lopes, 1982b: 365. Type species: *Penaissa quimaliensis* Lopes, 1982b; by original designation. *Syn. n.*

Cuzcomyia Lopes, 1982b: 367. Type species: *Cuzcomyia rufipes* Lopes, 1982b, by original designation. *Syn. n.*

Carchia Lopes, 1982b: 368. Type species: *Carchia andina* Lopes, 1982b [secondary junior homonym of *Xenoppina andina* Lopes, 1975d; [*Microcerella carchia* nom. nov.]], by original designation. *Syn. n.*

Azuya: Lopes (1982b: 363); erroneous subsequent spelling of *Azuayia*.

Boettia: Lopes (1982b: 363, 1982d: 607); erroneous subsequent spelling of *Boetia*.

Parahypopelta: Lopes (1969a: 8, 81); erroneous subsequent spelling of *Parahypopelta*.

Phaesarcodexia: Lopes (1969a: 8, 82; 1981: 327); erroneous subsequent spelling of *Phaesarcodexia*.

Townsendimya: Lopes (1969a: 9, 1974: 195, 1975a: 271, 1982b: 363); erroneous subsequent spelling of *Townsendimya*.

Diagnosis. — The genus *Microcerella* may be defined by the following character states:

- 1) Eyes green (live or fresh material);
- 2) Male protandrial segment black;
- 3) Hypandrial arm swollen at level of gonopod;
- 4) Postgena with at least some black setae close to genal suture.

The generic synonymizations presented above are straightforward in the sense that the identities of the type species of most genus-group names are well known and the monophyly of what is here considered as *Microcerella* has never been questioned. One exception is the taxon *Xenopiella dyscineti*, which was mentioned as being a potential member of the group by Lopes (1982b) but left with no further comment, as the holotype (which is the only specimen known) was not examined. This uncertainty resulted from the insufficient original description by Blanchard (1966), who gave a not very informative description of the male terminalia and did not provide any figures, only giving some chaetotaxic characters and stating that the terminalia were "muy abultado" (p. 183). I have examined the male holotype (MACN), which was mounted on cardboard and completely hidden in dense

mould. After partly cleaning of the specimen and remounting of the terminalia, it turned out to be a typical member of *Microcerella* (s.l.) and a junior synonym of *M. acridiorum*, syn. n. [Note that I have not revised the type material pertaining to the latter name, and I have followed Lopes (1969b), who reviewed its taxonomic history.] To corroborate this, and to facilitate recognition and identification, figures of the terminalia of the holotype of *X. dyscineti* are provided (figs. 29-32, compare Lopes 1969b: figs. 55-58). The holotype, which is perfectly intact except for dissected (but well preserved) terminalia, is heavily moulded and glued to a piece of cardboard on its right side. Terminalia and an empty puparium are mounted on separate pieces of cardboard pinned with the specimen. It is labeled "S/ *Dyscinetus gagates*, adulto.", "Tandil 6-XI-1958 Bazan, R.", "*Xenopiella dyscineti* .gen. et sp. nov. det. E. E. Blanchard", and "*Xenopiella dyscineti* E. E. Blanchard 1966 Holotypus [red label]".

Lopes (1982b) noted that the monotypic genus *Sarcophagulopsis* (type species: *S. trigonophymi*) possibly belonged to the Microcerellini. It is, however, a *Blaesoxiphidae* sensu lato and will be revised by Pape (in prep.).

Somewhat ironically, the identity of the type species of the genus *Microcerella* proper, *M. rufomaculata*, has never been thoroughly revised. Séguy (1925: 184) and Townsend (1931: 72, 1937b: 202) examined and redescribed the female holotype in MNHN, leaving no doubt of the assignment to *Microcerella* in the present sense, but no attempt has ever been made to associate the female with male specimens, for which reason the identity is highly uncertain. As other species are known from the male sex only, it is very probable that *M. rufomaculata* is a senior synonym of one of these [an obvious candidate being *M. sarcophagina*, the male holotype of which, however, may be lost, as mentioned below].

To accommodate all species of the taxa synonymized within *Microcerella* above, a number of new names have been proposed. These names, which all should be treated as nouns in apposition, are formed by using the name of their former genus as species epithet. Two other secondary homonyms are not covered in the list of generic synonyms. They are given below, following the procedure given above:

Microcerella boettia nom. nov. for *Boettia* [sic!] *ecuatoriana* Lopes, 1982d: 613 [secondary junior homonym of *Euparaphyto ecuatoriana* Lopes, 1982c: 495].

Microcerella austrohartigia nom. nov. for *Austrohartigia bicoloricauda* Lopes, 1981: 334 [secondary junior homonym of *Mesothrysia bicoloricauda* Endlerlein, 1928: 151].

The genus *Microcerella* is defined in the most narrow sense by Lopes (1969a) in the Neotropical catalogue, as he includes only one species, *M. sarcophagina*, besides the type species *M. rufomaculata*. The taxon *M. sarcophagina*, like *M. rufomaculata*, has remained enigmatic since its description by Thomson (1869), and the male holotype, which is the only specimen known, seems to be lost. [P. I. Persson (NMRS) has informed me that he has been unable to recover the holotype, which was sent as a loan to the late H. R. Dodge in the 1970's, and I did not succeed in finding it among the remnants of the Dodge-collection in FSCA.] Without any clue as to the structure of the terminalia, especially the aedeagus, the identity can only be a qualified guess whenever a detailed generic revision with extensive information of species present in the type locality concerned becomes available.

Lopes (1982b) provides a key to the genera of Microcerellini, and his *Microcerella* keys out mainly on the length of the first flagellomere relative to that of the pedicel, i.e. whether the former is "twice the length" (*Microcerella*) or only "a little longer" (*Microcerellamyia*) than the latter, and his measurements are apparently based partly on the original figures of Macquart (1851, pl. 22: fig. 1). It seems to me, therefore, that although *Microcerella rufomaculata* fits well within the tribe Microcerellini, and thus within *Microcerella* in the present sense, the narrow concept of *Microcerella* sensu Lopes needs revision and is tentative at best.

Lopes (1982b) discussed the limits of Microcerellini and mentioned *Austrohartigia*, *Doringia*, and *Aulacophyto* with ten, four, and five species respectively (the latter now with an additional three described by Tibana & Lopes (1988)), and he noted that "the majority of the remaining [27] genera are monotypic" (p. 359). Note that Lopes (1982b) divided the Microcerellini into the subtribes Microcerellina and Hypopeltina. A single two-state character separates these two groups, namely the possession of a pubescent versus a plumose arista (key entry only), but obviously both states cannot be assumed *a priori* to be apomorphic at this level as no third state from which they could be derived independently exists within the Sarcophaginae. No further explanation is given and the classification appears to be artificial. I have not been able to split the tribe into a few well defined and probably monophyletic groups, and instead of accepting the wealth of monotypic or very small genera that do not convey much information (and actually often are a burden for identification and information retrieval), I have lumped all species into one genus. Downes (1965) and Shewell (1987), who are dealing exclusively with the much sparser Nearctic fauna, also apply a broader concept when they include four species within *Microcerella*, one of which has been recorded from the neotropical region (M.

hypopygialis, see Lopes 1980, 1982a). *Microcerella* in this broadened sense is very well defined and equals the tribe Microcerellini as presented in Lopes (1982b, 1982e), except that I exclude the monotypic genus *Cryptosarcophila* as discussed below. Lopes (1969a: 7, 1982b: 361) mentioned that all species seen by him in fresh condition have green eyes, truly a unique condition within the Sarcophagidae. The green colour disappears after death although the eyes may retain a feeble greenish tinge (at least for some years). I have not seen live or fresh specimens of any of the Nearctic species, and although at least *M. texana* seems to be green-eyed (as judged from recently captured specimens in the USNM), information is needed from living or freshly killed material. Therefore, although I know of no exceptions within *Microcerella*, or of any (homoplastic) occurrences of green eyes in other sarcophagine genera, I cannot fully assess the strength of this character state for defining the genus. The majority of species of *Microcerella* have a bare, pubescent or short plumose arista and males of almost all species have a dark brown or black protandrial segment (first genital segment of authors, syntergosternite 7-8 of McAlpine 1981), distinctly contrasting to a bright red or orangish epandrium. No species have their male terminalia entirely red, and the black/black condition found in *M. muehni* and in the probably monophyletic clade [*M. hypopygialis* + *M. texana* + *M. valgata*] is most probably derived from the black/red condition. The aedeagus is highly characteristic by the very rigid connection between basi- and distiphallus that probably allows little or no articulation. Apart from a few species that have a highly modified aedeagus, the ventral surface of the distiphallus is equipped with a flat, sclerotized scale or plate. All species seen by me have the hypandrial arms more or less swollen at the level of the gonopods. The female terminalia show fused sternites 6-8 much like the condition seen in *Spirobolomyia*, *Comasarcophaga*, and many *Blaesoxiphia*, and tergite 6 is entire and more or less extended beyond the posterior rim of tergite 5.

Cryptosarcophila, with *C. chaetosa* as type species and only species included, was transferred to the Microcerellini by Lopes (1982b), but I prefer not to include this taxon in *Microcerella*. The reason for this is simply that I have not been able to recognize any convincing shared and assumed synapomorphic character state defining a clade containing only *Cryptosarcophila* and *Microcerella*. Although I have not examined any specimens of *C. chaetosa* myself, Lopes (1975e: 46) redescribed the species from the male holotype and noted that it has the "genital segments red", which most probably is plesiomorphic relative to the red/black or black/black condition in all *Microcerella*. Moreover, the arista is plumose and the aedeagus has no scalelike

ventromedian plate or process. *Cryptosarcophila chaetosa* resembles many *Microcerella* in having the white postgenal setae restricted to the hypostomal bridge below the neck, which probably is a derived condition relative to the groundplan of the Sarcophaginae. Many other genera, however, seem to share this character state, e.g. *Johnsonia*, *Neophyto* and perhaps *Notochaeta*, and it does not provide evidence for inclusion particularly in *Microcerella*.

Little information is available on the biology of *Microcerella*, but species have been bred from land snails, beetles and grasshoppers, and in the laboratory on horse blood serum (Blanchard 1966; Lopes 1969a, 1973).

Microcerella is most diverse in the neotropical region and especially at high altitudes and in the southern temperate zones. It was therefore surprising to find two specimens of an undescribed species of *Microcerella* from Bermuda, and even more so as the fauna of Sarcophagidae of these islands otherwise seems to consist entirely of a few widespread and possibly introduced species. Actually, the Diptera fauna of the Bermuda Islands is rather meager and with only few endemics. Many older Bermudan records of Sarcophagidae are misidentifications and only *Helicobia morionella*, *H. rapax*, *Oxysarcodexia ventricosa* and *Ravinia lherminieri*, all listed from Bermuda by Williams (1958, 1959), and all very common, widespread North American species, seem reliable (I have seen recently collected material of all but the latter species in USNM).

Research on the Nearctic *Microcerella*, evoked by the discovery of the Bermudan species, revealed that what has been considered a single taxon, *M. scrofa*, actually covers two sibling species. Previous illustrations of terminalia in Aldrich (1916: fig. 13), Roback (1954: fig. 39) and Lopes (1982c: figs. 43-47) seem to be of *M. scrofa* proper, while the species figured as *Hypopelta scrofa* in Hallock (1940: figs. 1-2) probably is its sibling *M. adelpha* (the surstylos figured by Hallock is perfectly *scrofa*-like, but this may be due to the rather simple outline provided by this author and the fact that the thornlike surstylos process is difficult to see in strict lateral view). Both new species of *Microcerella* are described below.

Microcerella bermuda sp. n. (figs. 33-36)

Type material. — Holotype ♂, "Bermudas [printed] viii 8 [handwritten, black ink] J.8 [handwritten, pencil] Davis [printed]" (MCZ). Paratype, 1♂, "Bermuda Islands July 4 1905, T. K" [only "4" handwritten] (ZMUC). Both types bear a label reading "Sarcophaga n. sp. det. ALDRICH".

Description.

Male. — Head: Narrowest part of frons 0.24× head width. Outer and inner vertical bristle well

developed. Two weak ocellars present, the bristles much weaker than the pair of postocellars. Frontal bristles (7)-8; row continuing to just above level of apex of scape and distinctly curving laterally when seen from above. Fronto-orbital plate otherwise bare. Parafacial plate with a row of 4 setae in ventral part close to eye margin. Postcranium with posteriormost postgenal setae and setae below occipital foramen white; other setae black. Scape distinctly raised above lunule, pedicel somewhat elongate, first flagellomere 1.5X as long as pedicel. Arista well developed, 2X as long as first flagellomere and short plumose. Palpus black.

Thorax: Proanepisternum and postalar wall bare. Metasternum setose. Chaetotaxy: acr = 0 + 1, dc = 4 (anteriormost 2 weak) + 3, ia = 2 (inner posthumeral + a weak presutural) + 2, sa = 2 + 3, pa = 2. Scutellum with 2-3 marginals (if 3 then the two posterior ones close together), one pair of weak discals, and one pair of apicals (slightly irregular in the holotype).

Wing: Tegula black or brownish, basicosta yellow, veins yellowish brown. Costal spine about 1.5X as long as crossvein r-m. Setal row of r_{4+5} just surpassing half the distance to r-m.

Legs: Midfemoral apical pv bristles not spinelike (no midfemoral comb), hind tibia without any elongated pv or p setae.

Abdomen: Ground colour black, microtomentum forming the usual silvery grey, tessellate and changing pattern. Tergite 1+2-3 without median marginal bristles, T4 with a weak pair, T5 with a complete row of marginals. ST3-4 with long setae with wavy or undulating tips.

Terminalia: Protandrial segment dark reddish brown, with a few bristles on disc and a complete row of marginals. Epandrium bright red. Cercus and surstyli densely setose, cercus broad and plate-like when seen in posterior (dorsal) view, S-shaped in lateral view. ST9 (hypandrium) with a reduced disc but with arms greatly swollen at level of gonopodal articulation. Gonopod shortened but rather broad at base, partly hidden by the swollen hypandrial arm (lateral view), and with setae scattered along most of the distal margin. Aedeagus with a short basiphallus that is rigidly hinged to the distiphallus. Distiphallus with a large transversely flattened plate carried on a narrow petiole from the ventral surface. Juxta present, well sclerotized and forming two arms slanting ventrally and basally. Lateral styli tubular, median stylus weakly sclerotized and somewhat inflated, all styli projecting between juxtal arms.

Length. — 10.0 mm.

Female. — Unknown.

Etymology. — A noun in apposition. Named for the type locality.

Distribution. — Nearctic: Bermuda Is.

Note. — Johnson (1904) mentions a "Sarcophaga sp. ? A smaller form of which a number of specimens were collected by Mr. Davis, July 8". These specimens may or may not include the holotype of the present species but obviously the note refers to the very collecting trip where it was taken (identical collector, locality and day + month) and settles with reasonable certainty the year when the holotype was collected as 1903, when Mr. C. Abott Davis visited the islands.

Microcerella adelphæ sp. n. (figs. 38, 40-43)

Type material. — Holotype ♂, USA: Maryland, Montgomery County, Rockville, 14.vi.1969, G. Steyskal (USNM). Paratypes, Canada: Ontario, Ottawa, 1♂, 4-7.viii.1982, L. Huggert (ZML); Quebec, Mount Tremblant, Lac aux Atocas, 1♂, 28.viii.1956, E.B. Thurman, "Bitting & Sweeping" (USNM). — USA: Georgia, 1♂, [no date], C. V. Riley [terminalia lost] (USNM); Minnesota, Eaglesnest, 1♂, 29.vii.1958, W. V. Balduf (USNM); New York, Tompkins Co., [...] (illegible ?Ellio), 1♂, 25.viii.1956, B. Foote, lab reared ex *Polygura thyrodes* (ZMUC); New York, Tompkins Co., Varna, 1♂, 17.vii.1946, A. Stone (USNM); North Carolina, Great Smokie Nat. Park, Newfd Ridge, 1♂, 11.vii.1941, A. L. Melander (USNM); Virginia, Great Falls, 1♂, 21.vi.1931, A. C. Melander, 1♀, "x.23,20", J. M. Aldrich (both in USNM); West Virginia, Cranberry Gla., 1♂, 2.vi.1955, H. V. Weems (USNM).

Description

Male. — Very similar to *M. scrofa*. I have found only few diagnostic characters, all pertaining to the terminalia, and the description is accordingly restricted to these structures. Moreover, to facilitate a separation from *M. scrofa*, the description is given as one entry of a recognition couplet. For details of general morphology, the description of *M. scrofa* in Aldrich (1916) should be consulted.

- Surstyli distally evenly rounded. Distiphallus broadest proximal to middle (lateral view) and with the appendages at the ventral surface rather slender (figs. 37, 39, 44) *Microcerella scrofa*
- Surstyli distally with a concave incision and a thornlike process. Distiphallus broadest at or distal to middle (lateral view) and with the appendages at the ventral surface more compact (figs. 38, 40, 43) *Microcerella adelphæ*

One female has been included in the type series of *M. adelphæ* although I cannot separate it morphologically from that of *M. scrofa*. Geographical evidence, however, suggests that *M. adelphæ* may have a more easterly extended distribution relative

to *M. scrofa* (see below). A female from Ohio (Amherst) is accordingly judged to belong to *M. scrofa*.

Etymology. — A noun in apposition. From the Greek *adelphe* = sister, the name refers to the probable sister group relationship with *M. scrofa*.

Distribution of *M. adelphae*. — Nearctic: Canada (Ontario, Quebec), USA (Georgia, Maryland, Minnesota, New York, Virginia, West Virginia).

Biology. — The only information available is the breeding record from the snail *Polygura thyroides* (from label of one of the paratypes from New York State), and *M. adelphae* is probably predatory on snails, as many of its congeners. *Microcerella adelphae* may actually be the "undescribed species [which] parasitizes snails" mentioned by Downes (1965: 951). Nothing is known of the biology of *M. scrofa*.

Distribution of *M. scrofa*. — Nearctic: Canada (Ontario [nr. Stratford]), USA (Alabama [Birmingham], Illinois [Algonquin], Indiana [Lafayette], Kansas [Topeka], Louisiana [Opelousas], Ohio [Amherst], Texas [College Station], and Wisconsin [state record only]). The specimens on which this distribution is based are deposited in USNM (US records) and ZML (Canadian record).

The apparent sympatry of *M. adelphae* and *M. scrofa* in at least part of their range (one male of each species from Canada: Ontario) is strong evidence that the rather slight differences reflect a reproductive barrier.

The closest relative of *M. adelphae* is most probably *M. scrofa*, as already mentioned. Both species possess a highly modified distiphallus with lateral sclerotized plates that extend posteriorly, thereby forming a deep, narrow groove along the posterior surface. Moreover, the gonopods are very characteristic by being greatly extended anteriorly, strongly curved upwards (or dorsally), and almost joining in the median plane (fig. 42). The group consisting of the sibling species *adelphae* + *scrofa* is probably the sister group to *Microcerella bermuda*. The character corroborating this hypothesis is the shape of the gonopod. In all three species, the gonopod has transformed from the elongate and more or less narrow structure found in all other *Microcerella* into a short or low, but very broad plate. The scattered setae that cover most of the distal margin may be used as a morphological landmark indicating the homologue of the posterior (or dorsal) margin of the plesiomorphic gonopod. The sister group of *adelphae* + *scrofa* + *bermuda* will probably be found among the Neotropical members of the group, as the three remaining Nearctic species of *Microcerella* may have the Argentinean species *M. muehni*

as their closest relative, these four species sharing the derived black/black condition of terminalia.

Genus *Spirobolomyia*

Spirobolomyia Townsend, 1917a: 43. Type species: *Sarcophaga singularis* Aldrich, 1916, by original designation.

Diagnosis. — The genus *Spirobolomyia* may be defined by the following character states.

- 1) Male mid femur apically with a row of comb-like posteroventral spines;
- 2) Male abdominal sternite 5 with bristles along the posterior margin;
- 3) Male abdominal sternite 5 with a pair of bristly pads on the disc;
- 4) Male cercal prong bent backwards;
- 5) Male cercus with a sinuous lateral margin (posterior view);
- 6) Male cercus with short spinelike setae on the dorsal surface;
- 7) Basal parameral sclerite elongated ("additional forcipes" of Lopes 1975f);
- 8) Aedeagus with a beaklike projection arching over the heavily sclerotized juxta (fig. 48);
- 9) Aedeagal vesica beaklike and sclerotized;
- 10) Female abdominal sternites 6-8 fused;
- 11) Female abdominal tergite 6 with the median (= dorsal) part of the posterior margin devoid of setae and produced in a tongue-like projection (Lopes 1975f: figs. 8, 17, 26).

Townsend seldom explained the etymological derivation of his numerous generic names, but when he erected the genus *Spirobolomyia* with a type species that had been bred from a millipede, it seems probable that he, although he gave no mention of species other than the type species, included *Sarcophaga flavipalpis* as well, as this very similar species had been "reared ... from a myriapod" (Aldrich 1916: 258). Accordingly, he later stated that *Spirobolomyia* "Ranges in two species" (Townsend 1938: 68). Downes (1965) widened the concept by including *Sarcophaga basalis* and *S. ohioensis* in *Spirobolomyia* (as subgenus of *Blaesoxiphia*), the biology of which is still unknown. It might be guessed that they are all parasitoids of the millipede genus *Narceus*. Note that I am here following Keeton (1960), who revised the Spirobolidae and argued that *Spirobolus* (consistently misspelled *Sparobolus* by Aldrich 1916: 186, 258) should be used for the group of Old World (China) species only, while *Narceus* should be applied to its New World sister group. As the name *Narceus* is the oldest genus-group name within the tribe Spirobolini, *Narceus* is the valid name in the present context whether or not Keeton's infratribal classification is accepted.

Species of *Spirobolomyia* are mainly distributed

in the eastern and southeastern parts of the Nearctic Region but extend along the east coast into the northern part of the neotropical region. The range extends from Canada: southern Quebec, (1♂ of *S. flavipalpis* in ZMUC) south to Mexico: Tamaulipas (1♂ of *S. latissima* in FSCA, see under type material below) and Chiapas (8♂ 2♀ of *S. ohioensis* in CNC). The western limit of distribution seems to run through Wisconsin, Iowa, West Virginia, and Alabama (Downes 1965), and the Nearctic distribution is closely matched by the distribution of *Narceus* given in Keeton (1960).

The life habit, although only known for two species and without any evidence that no other food source can be utilized, is interesting insofar as very few Diptera parasitize or prey upon millipedes. Within the Sarcophagidae, I know of only two other records: Specimens of *Blaesoxiphia beameri* in USNM (4♂, USA: California, Riverside) bear a label reading "Ex *Tyllobolus* sp. near *hebes*" probably referring to a species of the spirobolid genus *Hiltonius*. Although this may refer to parasitism, predation or even scavenging, the food source nevertheless is a millipede. No other information is available on the biology of *B. beameri*. A single male specimen of *Sarcophaga iulicida* from Portugal (BMNH), with an affiliation in the subgenus *Pierretia* sensu stricto of Verves (1986), was bred from a specimen of *Ommatoiulus moreleti* (Pape 1990). Note that the parasitism of millipedes has not been used as a character state corroborating the monophyly of *Spiroboomyia*. Parasitism of a particular taxon is difficult to handle in a character analysis as parasites do not parasitize taxa as such, and although it seems reasonable that the peculiar habit of *Spiroboomyia* is evidence of phylogenetic relationship I prefer to avoid an explicit scoring.

Spiroboomyia was, like *Fletcherimyia*, included in *Blaesoxiphia* as a subgenus by Downes (1965). However, all *Spiroboomyia* possess tubular styli that are free of each other and apparently functional, i.e. sperm conducting, and they do therefore not form part of the probably monophyletic group of species with only the median stylus tubular and with platelike lateral styli that are fused in the median plane. The latter group is the genus *Blaesoxiphia* in the sense of the present author. The male midfemoral comb, the presence of short spines on the dorsal surface of the male cercal prong, the recurved male cercal prong, and the fused female abdominal sternites 6-8, however, are character states *Spiroboomyia* shares with *Blaesoxiphia*. At least the latter four states seem derived with regard to the groundplan of the Sarcophaginae, and including *Spiroboomyia* within *Blaesoxiphia* (i.e. widening the concept of the latter) may be theoretically sound on the present state of knowledge, and my reason for not doing this is, as given for *Comasarcopaga* and *Fletcherimyia*, that the

monophyly of the resulting taxon seems, at least to me, to be much more tentative than the monophyly of the groups included. A comprehensive phylogenetic analysis of all sarcophagine genera is needed to settle this issue. Lopes (1975f: 156) simply discarded a relationship between *Spiroboomyia* and *Blaesoxiphia* by stating that "there is no close relationship between the two genera", but he later (1988a: 130) elaborated on this postulate by referring explicitly to the "long styli of glans" (= lateral styli of the present paper) being present in species of *Spiroboomyia* but absent in his Impariini (= *Blaesoxiphia* (in part) of the present paper). The possession of functional lateral styli will corroborate that *Spiroboomyia* does not form part of the clade here considered under the name *Blaesoxiphia* (unless other evidence favour a reversal), but as the character state obviously is plesiomorphic at the level of the Sarcophaginae, it is totally uninformative regarding the phylogenetic position of *Spiroboomyia* relative to *Blaesoxiphia*.

Species limits were discussed in detail by Lopes (1975f), but the number of specimens at his disposal was rather limited and a more extensive material has revealed another, previously undescribed species. As only characters found in the male terminalia distinguish this species from *S. ohioensis*, and as species of *Spiroboomyia* in general are separable only by reference to their terminalia and sternite 5, I have restricted the description to include these structures only. Information on general appearance of *Spiroboomyia* can be found in Aldrich (1916), Hall (1927), Townsend (1938) and Lopes (1975f).

Spiroboomyia latissima sp. n. (figs. 45-48, 50)

Type material. — Holotype ♂, USA: Texas, Menard, 1929, E. O. Cushing (USNM). Paratypes, USA: Texas: 16♂, data as holotype (14 in USNM, 2 in ZMUC); 1♂ v.1930, otherwise as holotype (USNM); NW Blanco Co., Davis Ranch, 1♂, 22.iv.1959, J. F. McAlpine (CNC); Reagan Wells, 1♂, 27.vi.1927, R. W. Laake (USNM); Sonora, 1♂, 10. [month not interpreted] 1920, O. G. Babcock (USNM); Hidalgo Co., 7♂, 29.iii.-9.x.1946, USPHS dysentery fly trap (USNM); Hidalgo Co., 3♂: 4.ii.1932, 1♂: 3.viii.1934, H. J. Reinhard (3 in CNC, 1 in ZMUC); Brewster Co., Big Bend National Park, Basin, 1♂, 14.vi.1950, R. F. Smith (AMNH). — Mexico: Tamaulipas, 9 km W Antiguo-Morelos, 1♂, 21.vii.1954, Univ. Kansas Exp. (FSCA).

Description

Male. — Abdomen: Sternite 5 deeply incised and with strong, spinelike bristles along the basal (or median) half of the posterior margin of each lobe. A pair of raised pads with strong bristles on the posterior, flattened surface are present on the disc.

Terminalia: Cercus very broad in posterior view, with a sinuous outer (or lateral) margin and a greatly swollen flaplike extension basally on the

cercal prong. A few short spines are present on the dorsal surface and along the margin of the hump-like lateral convexity. Cercal setae are arranged in two groups: a smaller one close to the median line of articulation between the cerci, and a more extensive one distal to this. Aedeagus with the dorsal (or posterior) surface raised into a narrow crest. Vesica well sclerotized and of about the same size as the beaklike structure arching over the juxta.

Female. — Probably very like the female of *S. ohioensis*. Among nine females from Texas, Hidalgo Co., 14.iii.-23.x.1946 (USNM), all caught in dysentery fly traps, may be specimens of *S. latissima*. I have not been able, however, to find any differences between these and a female specimen of *ohioensis* pinned with a presumed conspecific male (USNM), and as the distribution of these two species seems to be largely sympatric, I have not included any females in the type series.

Etymology. — A Latin adjective, from *latissimus* = the broadest. The name refers to the male cercus, which is very broad in posterior view.

Distribution. — Nearctic: USA (Texas). Neotropical: Mexico (Tamaulipas).

Females of *Spiroboholomyia* are very similar and I cannot at present identify female specimens to species with any certainty. This implies a problem, as the holotype of *Sarcophaga pallipes* is a female. Aldrich (1930) examined this type and established its relationship, but he was not able to make a species level identification: "I can not separate [it] from females of *singularis* and several others" (p. 19). Townsend (1938) and Roback (1954) considered *S. pallipes* a senior synonym of *S. singularis*, while Downes (1965) listed *pallipes* as "Probably *Blaesoxiphia* (*Spiroboholomyia*) sp.". Lopes (1975c) likewise examined the type of *pallipes* and synonymized it with *Sarcophaga basalis*, but his decision obviously was tentative as he "was unable to [find] good characters to separate the female[s] of the *Spiroboholomyia* with red legs" (p. 548). Apparently, his decision was based largely on the equal size of the primary types, which really does not provide especially convincing evidence as to their conspecificity. When Lopes (1975f) later produced a key to species of *Spiroboholomyia*, he did not include the females and he did not examine any female specimens of *S. ohioensis*. For the present paper, I have accepted the synonymy of *S. basalis* with *S. pallipes*, awaiting more information on diagnostic female character states.

Roback (1954) illustrated the aedeagus and abdominal sternite 5 of *S. singularis* (as *pallipes*), *S. flavipalpis* (as *flavipes*, error) and *S. basalis*. Lopes (1975f) gave a detailed description of these species

as well as of *S. ohioensis* and provided illustrations of various parts of both male and female terminalia. Both authors should be consulted for additional information. The key of Lopes (1975f), however, is not easy to use and the posterior view of the male cerci is provided for two species only (that of *S. basalis* even at a slightly skewed angle). The posterior outline of the male cerci provides a very easy means of identification and has the advantage that this attribute often is visible even in specimens with only partly spread terminalia. For the present paper, I have provided illustrations of the posterior cercal outline for all species (figs. 49-53), and for completeness a couplet is provided to separate *S. latissima* from the very similar *S. ohioensis*:

- Aedeagus with long vesica and a crest running along the dorsal surface (fig. 48). Cercus very broad in posterior view (figs. 46, 50). Setae of cercal base separated into two groups by an area with no or very few setae: A small group close to the suture between the cerci and a larger group along the outer (or lateral) margin (fig. 46) *latissima*
- Aedeagus with shorter vesica (Lopes 1975f: fig. 35), dorsal surface distinctly keeled but not raised into a crest. Cercus narrower in posterior view (fig. 49). Setose part of cercal base without any interruption, setae forming a continuous cover from suture between the cerci and out along the outer (or lateral) margin *ohioensis*

Genus *Tripanurga*

Tripanurga Brauer & Bergenstamm, 1891: 367. Type species: *Sarcophaga albicans* Wiedemann, 1830, by designation of Townsend (1916: 9).

Thelyleptocnema Townsend, 1917a: 43. Type species: *Sarcophaga incurva* Aldrich, 1916, by original designation.

Glaucosarcophaga Townsend, 1917a: 45. Type species: *Glaucosarcophaga knabi* Townsend, 1917a [= *Sarcophaga albicans* Wiedemann, 1830], by original designation.

Metoposarcophaga Townsend, 1917a: 46. Type species: *Sarcophaga pachyprocta* Parker, 1916 [junior primary homonym of *pachyprocta* Hagen, 1881; = a species of the *Sarcophaga importuna* Walker complex], by original designation. *Syn. n.*

Zygastropygia Townsend, 1917b: 191. Type species: *Zygastropygia aurea* Townsend, 1917b, by original designation.

Cacotrophus Reinhard, 1947: 99. Type species: *Cacotrophus beameri* Reinhard, 1947, by original designation.

Erucoiphaga Reinhard, 1963a: 75. Type species: *Erucoiphaga trilobis* Reinhard, 1963a, by original designation. *Syn. n.*

Diagnosis. — The genus *Tripanurga* may be defined by the following character states:

- 1) Aedeagal basiphallus with an epiphallus-like process;
- 2) Aedeagal basiphallus shaped as an elongated

and narrow tube, strongly contrasting to the compact distiphallus (*T. aurea* showing a secondary thickening);

- 3) Aedeagal distiphallus compact and more or less globular;
- 4) Aedeagal distiphallus with a fringe of filiform processes at the anterior margin (Lopes 1978b: figs. 6-8; the present figs. 57, 61);
- 5) Parameral bristle slightly flattened;
- 6) Ejaculatory apodeme large;
- 7) Male cercal prong bent backwards.

The groundplan of the probably monophyletic group *Paramacronychiinae* + *Sarcophaginae* is characterized by an almost completely reduced epiphallus, but in all species of *Tripanurga* the proximal part of the basiphallus is extended into a distinct process that is broad at the base, tapers gradually and slants backwards or posteriorly (Roback 1954: figs. 316-335; Lopes 1978b: fig. 6; Shewell 1987: fig. 58c; the present figs. 57, 61). Shewell (1987) applied the term epiphallus to this structure, but I prefer to avoid it as the basiphallitic process in *Tripanurga* cannot be considered homologous to the epiphallus of the Miltogrammatinae and Calliphoridae but rather to its base.

Character states 3-5 are here considered autapomorphic, and probably state 2 as well as the condition in *T. aurea*, which possesses a rather strong basiphallitic tube (fig. 61), is judged to be secondary. The shape of the distiphallus may indicate a transformation with a gradual increase in the size of the dorsal humps: *importuna*-type → *villipes*-type → *sulculata*-type → *aurea*-type (compare Roback 1954: plates 23-24, and the present figs. 57, 61). The unique (i.e. autapomorphic) shape of the *aurea*-type distiphallus makes a reversed polarity highly improbable. If this is accepted, *T. aurea* cannot be considered the sister group of all other *Tripanurga* and the broad basiphallus found in this species has to be considered a secondary specialization (i.e. apomorphic).

The genus *Tripanurga* was described by Brauer & Bergenstamm (1891) to contain "1. *albicans* Wd. (*Sarcophaga*). 2. *dimidiata* Wd. 3. *bicolor* S.M.C. Bras" (p. 367). The latter name is apparently a nomen nudum while the second probably is Wiedemann's (1830) *Sarcophaga dimidiata*, which currently is regarded as a species of *Notochaeta*, e.g. by Lopes (1969a). Two years later Brauer & Bergenstamm (1893) included (or mentioned) *albicans* only, and Townsend (1916) designated this as the type species, probably without having seen the type or any conspecific specimens. Townsend spent six months of 1928 visiting European and American museums and examining a large number of types, and he later published the results in various papers. For *Sarcophaga albicans*, he gave the type depositaries as: "Male Ht in Wien and male Pt in Lima"

(Townsend 1931: 75), which would have been an effective lectotype designation if only a single syntopic specimen had been present in Vienna (NMW). Townsend probably incorporated one of the original type specimens in his own collection, and when he later moved from Lima to Washington, D.C., bringing his collection along, the paratype (which with the present lectotype designation automatically becomes a paralectotype) was deposited in the USNM (Townsend 1937b: 221). Aldrich went to Europe in 1929, i.e. after Townsend, but he published his results a year earlier, although without designating any of the specimens examined as lectotypes. He did, however, give an extensive description of two males of *Sarcophaga albicans* in NMW, "Undoubted types" (Aldrich 1930: 8). As both these males are still present in NMW, and as Townsend's visit in Vienna antedated that of Aldrich, Townsend must have incorporated one of three original syntopic males in his own collection and not one of the two seen by Aldrich as stated by Lopes (1978b). One of these two remaining specimens was then chosen by Townsend to be the holotype. This is to be considered as a valid lectotype designation only if the specimen in case can be properly recognized, but as Townsend neither labelled one of the males in question (he never labelled his 'designated' lectotypes) nor cited any information that could refer to one particular specimen, I have simply regarded Townsend's designation as invalid and chosen one of the two available specimens, which I have labelled as lectotype. This male is in good condition except that it lacks right first flagellomere + arista, left foretarsus, right midleg, left hind leg, right hind tarsus, and has the terminalia dissected and glued to the lowermost label. It is labelled "Brasilien" (printed) and "albicans Wd J 48 Coll. Winthem" (last two words printed), and its identity as *Tripanurga albicans* is herewith verified. The two paralectotypes in USNM and NMW respectively have been labelled as such.

Silvestri (1903) described the species *Tripanurga termitophila*, probably on a single female which he recovered and apparently bred from a termite nest. The holotype has never been revised [I have not tried to locate this specimen, which is from Santa Ana, Misiones, in Tucumán Province, Argentina, and not just "America Meridionalis" as stated by Lopes (1969a: 47)] and *Tripanurga* has in practice remained monotypic since Brauer & Bergenstamm (1893) excluded (or omitted) *Sarcophaga dimidiata*. Some authors, however, have stressed the strong similarity to *Metoposarcophaga* and related taxa. Aldrich (1930) mentioned that *Sarcophaga albicans* resembled the type species of both *Metoposarcophaga* and *Zygastropyga*, and Roback (1954: 81) mentioned that *Tripanurga* "will probably fall within the genus *Metoposarcophaga*" as *T. albicans*

seems to be "very close to the subgenus *Zygastrophyga*". Neither author, however, made an explicit synonymization. Downes (1965) employed a broad concept of *Metoposarcophaga*, although he did not include *Erucocephaga*, but he probably did not consider *Tripanurga* at all as *T. albicans* has not yet been found north of Mexico. Lopes (1969a) listed *Sabinata*, *Tripanurga* and *Zygastropyga* as distinct genera, while Shewell (1987) separated both *Thelylepticoecema* and *Erucocephaga* from *Metoposarcophaga*. I think that using *Tripanurga* in the more inclusive sense presented above should be preferred for the following two reasons: Monotypic genera as *Tripanurga* (with *T. albicans* only) and *Erucocephaga* are avoided, and the monophyly of the resulting taxon is better corroborated. Accepting a monotypic *Tripanurga* will leave *Metoposarcophaga*, e.g. sensu Downes (1965), without any assumed apomorphies not shared by *T. albicans*, and further splitting with the creation of additional monotypic genera has to be accepted. The genus *Erucocephaga* provides a somewhat different case as the straight or slightly anteriorly curved male cercus of *triloris* is unique within *Tripanurga* (in the broad definition) and may be plesiomorphic relative to the remaining species where the cercus is distinctly curved backwards. This would be an argument for treating this species as the sister group to all other *Tripanurga*, and it may, therefore, be an argument for maintaining the genus *Erucocephaga*. I still think, however, that this is unwarranted simply because the little new information presented (= the possible monophyly of *Tripanurga* excl. *triloris*) is made up for by a similar loss (= the monophyly of *Tripanurga* incl. *triloris*). Moreover, as no well corroborated sister group of *Tripanurga* incl. *triloris* has been proposed, the monophyly of *Tripanurga* excl. of *triloris* will be highly tentative, and one ends with nothing but another genus-group name to handle. Actually, if *Argoravinia* turns out to be the best candidate for the sister group, as discussed below, the cercal condition in *triloris* must be considered as derived from the bent cercus of its congener.

In conclusion, the monophyly of *Tripanurga* in the present, broadened sense is corroborated by some very convincing autapomorphic character states of the male copulatory apparatus, which furthermore makes the taxon easily recognizable, at least in the male sex.

Some of the character states listed in the diagnosis may be apomorphic at a higher (i.e. more inclusive) level. The large ejaculatory apodeme, for example (Hallock 1940: fig. 13; Lopes 1978b: fig. 6; Shewell 1987: fig. 58c), is likewise found in the genus *Argoravinia* (although not quite as large) and it may be taken as evidence for considering these two genera as sister groups. Hall (1933: 255) even stated that *Argoravinia* "appears greatly like the

genus *Metoposarcophaga*". Moreover, a rather broad male front (although with proclinate orbital bristles in *albicans* and *triloris* only) is likewise shared with *Argoravinia*, and in all species of *Tripanurga* except *T. triloris*, the male cercus is bent backwards or posteriorly (figs. 54, 58), somewhat like the condition found in *Argoravinia*. The almost straight male cercus in *T. triloris* may then represent a derived state.

Tripanurga guatemala sp. n. (figs. 54-57)

Type material. — Holotype ♂, Guatemala: Antigua, El Salto, 1.v.[no year], J. M. Aldrich (USNM). Paratypes, Guatemala: Antigua, 1♂, 14.v.1923, E.G. Smyth (ZMUC); Guatemala City, 1♂, vii.1923, E. G. Smyth (USNM).

Description

Male. — Head: Narrowest part of frons 0.27-0.29× head width. Outer and inner vertical bristle well developed, fronto-orbital plate densely setose and without proclinate orbitals. Uppermost frontal bristle strong and reclinate. Upper half of parafacial plate with some scattered setulae, lower part with a row of setulae close to eye margin. All postcranial setae, including those on hypostomal bridge, black. Head entirely silvery microtomentose. Antennal pedicel blackish with brownish base and apical margin, first flagellomere blackish grey. Palpus black.

Wing: Tegula black, basicosta yellow. Vein r_1 setose from base almost to the knob at level of subcostal bend/costal break, r_{4+5} setose from base almost to crossvein $r-m$.

Legs: All femora with long setae and without av or pv bristles. All tibiae, especially mid- and hind, with dense villosity.

Abdomen: Tergite 1+2-3 without median marginal bristles, T4 with a median pair, and T5 with a complete row of marginals.

Terminalia: Colour red. Cercal prong slender, prongs closely adjoining in the distal half leaving a small window at base. Surstyli broad, with a fringe of long flattened setae.

Length. — 11.0-13.0 mm.

Female. — Unknown.

Etymology. — A noun in apposition. Named for the type locality.

Remarks. — *T. guatemala* is most probably the sister species of *T. villipes*, the monophyly of this group being well corroborated by at least three distinctive character states that may be derived relative to the groundplan of *Tripanurga*:

- 1) Postcranial setae all black;
- 2) All legs equipped with dense, long pilosity and no anteroventral or posteroventral bristles;
- 3) Strongly convex ventral margin of the surstyli.

lus with a row of closely set, strong, and elongated setae.

Tripanurga aurea (figs. 58-66)

Distribution. — Nearctic: USA (Arizona, California), Mexico (Baja California, Sonora). Neotropical: Mexico (Guerrero, Jalisco, Morelos), Nicaragua.

The reason for discussing the present species is that it seems to be split into two populations, a Baja Californian population and a mainland population, with some striking morphological differences between the two. Indeed, these differences were thought to indicate a specific separation until I recovered specimens from northern Baja California showing intermediate character states and reticulate character state combinations. Two characters showing especially pronounced differences, the outline of the surstylos and the shape of the male abdominal sternite 5, are described in more detail below.

The typical Baja Californian form (figs. 58-63) has a slight posteroventral concavity of the surstylosular margin (best seen in lateral view as in fig. 58), and the lobes of the male abdominal sternite 5 are strongly swollen apically and transversely flattened posteriorly (fig. 62). Specimens of the mainland form have the surstylos deeply incised from the posteroventral margin (figs. 64, 65), and the lobes of abdominal sternite 5 are flat and evenly rounded (fig. 66), i.e. they represent unmodified lobate extensions of the sternal disc. The aedeagus is completely identical in both populations (fig. 61), and no differences have been found in the female sex.

It is interesting that the Baja Californian form does not seem to be just a peripheral isolate that has diverged from its plesiomorphic ancestral population on the mainland. Both populations (i.e. gene pools) have probably diverged from their common (hypothetical) ancestor by the acquisition of at least one autapomorphic character state, the Baja Californian form having developed the obviously apomorphic swollen lobes of abdominal sternite 5 and the mainland form the incised surstylos. The two forms are morphologically homogeneous throughout their range, but in the area where they occur simultaneously (northern Baja California), intermediary specimens and specimens with transposed character state combinations, i.e. incised surstylos and swollen lobes of ST5, may be caught at the same locality. Therefore, reproductive isolation does not seem to have been established, and rather than proposing a formal subspecific name for the Baja Californian population, I prefer to use the term "form", awaiting further studies of the population(s) showing intermediary conditions.

Material examined.

Type material. — USA: Holotype ♂, Arizona, Tempe, [no date], Webster (USNM).

Other material. — Mexico: Sonora; Alamos, 4♂, 20-27.ii.1963, P. H. Arnaud, Jr. (USNM); Jalisco, Labarca, 1♂ 1♀, 3.x.1934 [no collector] (UNAM); Guerrero, Arcelia, 1♂, 21.x.1947, W. G. Downs (UNAM); Morelos, 5 km SW Amacuzac, 3♂, 8.vi.1979, J. Butze (2 in UNAM, 1 in ZMUC); Baja California Norte, Arr. Santo Domingo, 5.7 mi E Hamilton Ranch, dam site, 42♂ 52♀, 23.iv.1963, H. B. Leech & P. H. Arnaud, Jr. (FSCA); Golfo California, Isla Angel de la Guarda, Puerto Refugio, 2♂, 6.ii.1986, F. Arias (UNAM, ZMUC); Golfo California, Isla Espiritu Santo, 1♂ 1♀, 11.i.1987, L. Cervantes (UNAM). — Nicaragua: Chinandega, 1♂, [no date], Baker (USNM).

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REFERENCES

- Aldrich, J. M., 1916. *Sarcophaga* and allies. — La Fayette, Thomas Say Foundation; 302 pp., 16 pls.
- Aldrich, J. M., 1930. Notes on the types of American two-winged flies of the genus *Sarcophaga* and a few related forms, described by the early authors. — Proceedings of the United States National Museum 78(12): 1-39, 3 pls.
- Beaver, R. A., 1979. Biological studies of the fauna of pitcher plants *Nepenthes* in west Malaysia. — Annales de la Société Entomologique de France 15(1): 3-18.
- Blanchard, E. E., 1939. Los sarcofágidos argentinos. Contribución a su conocimiento. — Physis 17: 791-856.
- Blanchard, E. E., 1955. Nuevos sarcofágidos acridiófagos argentinos (Diptera). — Revista de la Sociedad entomológica argentina 18(3-4): 27-34.
- Blanchard, E. E., 1966. Dípteros parásitos de escarabajoideos argentinos. — Revista investigaciones Agropecuarias

ria, Ser. 5, Patologia Vegetal 3(11): 175-229.

Brauer, F. & J. von Bergenstamm, 1891. Die Zweiflügler des Kaiserlichen Museum zu Wien. Part II. - Denkschriften der Akademie der Wissenschaften Wien, Mathematisch-naturwissenschaftliche Klasse 58: 39-446.

Brauer, F. & J. von Bergenstamm, 1893. Die Zweiflügler des Kaiserlichen Museum zu Wien. Part III. - Denkschriften der Akademie der Wissenschaften Wien, Mathematisch-naturwissenschaftlichen Klasse 60: 89-240.

Buckell, E. R. & G. J. Spencer, 1957. A preliminary list of the flesh flies of British Columbia (Diptera: Sarcophagidae). - Proceedings of the Entomological Society of British Columbia 54: 29.

Cody, J. D. & S. S. Talbot, 1973. The pitcher plant, *Sarracenia purpurea* in the northwestern part of its range. - Canadian Field Naturalist 87: 318-320.

Coquillett, D. W., 1895. Descriptions of new genera and species. Pp. 307-319 in: Johnson, C. W. : Diptera of Florida. - Proceedings of the Academy of Natural Sciences of Philadelphia 47: 303-340.

Curran, C. H., 1928. Insects of Porto Rico and the Virgin Islands. Diptera or two-winged flies. - Scientific Survey of Porto Rico and the Virgin Islands (New York Academy of Sciences) 11: 1-118.

Dodge, H. R., 1965. Neotropical Sarcophaginae with impressed scutellum (Diptera, Sarcophagidae). - Annals of the Entomological Society of America 58(3): 252-259.

Dodge, H. R., 1967. Some new American Sarcophagidae (Diptera). - Pacific Insects 9(4): 679-686.

Downes, W. L., Jr., 1965. Family Sarcophagidae. - Pp. 933-961 in Stone, A. et al., eds. . A catalog of the Diptera of America north of Mexico. United States Dept Agric., Agricultural Handbook 276, iv + 1696 pp. Washington.

Enderlein, G., 1928. Sarcophagiden-Studien II. - Konowia 7: 147-153.

Engel, O., 1931. Die Ausbeute der deutschen Chaco-Expedition 1925/26. Diptera. XXVIII. Sarcophagidae. - Konowia 10: 140-154.

Fish, D., 1976. Insect - plant relationships of the insectivorous pitcher plant *Sarracenia minor*. - Florida Entomologist 59(2): 199-203.

Fish, D. & D. W. Hall, 1978. Succession and stratification of aquatic insects inhabiting the leaves of the insectivorous pitcher plant *Sarracenia purpurea*. - American Midland Naturalist 99(1): 172-183.

Forsyth, A. B. & R. J. Robertson, 1975. K reproductive strategy and larval behavior of the pitcher plant sarcophagid fly, *Blaesoxiphafletcheri*. - Canadian Journal of Zoology 53: 174-179.

Hagen, H. A., 1881. List of N. American Sarcophagidae, examined by R. H. Meade, Esq., Bradford, England. - Canadian Entomologist 13: 43-51.

Hall, D. G., 1927. A new species of *Sarcophaga* (Diptera) from Ohio. - Insectorum Inscitiae Menstruus 14: 176-178.

Hall, D. G., 1931. New Texas Sarcophaginae (Diptera: Calliphoridae). - Entomological News 42: 280-286.

Hall, D. G., 1933. The Sarcophaginae of Panama (Diptera: Calliphoridae). - Bulletin of the American Museum of Natural History 66: 251-285.

Hall, D. G., 1937. Calliphoridae (Sarcophaginae, Calliphorinae). - Diptera of Patagonia and South Chile. Part 7, fasc. 3: 347-384. British Museum (Natural History), London.

Hall, D. G., 1938. New genera and species of South American Sarcophagidae (Dipt.). - Arbeiten über morphologische und taxonomische Entomologie aus Berlin-Dahlem 5: 253-259.

Hallock, H. C., 1940. The Sarcophaginae and their relatives in New York, part I. - Journal of the New York Entomological Society 48: 127-153.

Johnson, C. W., 1904. A revised list of the Diptera of Bermuda. - Psyche 11: 76-80.

Keeton, W. T., 1960. A taxonomic study of the milliped family Spirobolidae (Diplopoda: Spirobolida). - Memoirs of the American Entomological Society 17, ii + 146 pp. + 18 pls. + index (i-ii).

Krajina, V. J., 1968. Sarraceniaceae, a new family for British Columbia. - Syesis 1: 121-124.

Lopes, H. S., 1938. Notas sobre Sarcophagidae neotropicos. Um novo genero e algumas novas especies. - Memórias do Instituto Oswaldo Cruz 33: 333-348, 6 pls.

Lopes, H. S., 1946. Sarcophagidae do Mexico, capturado pelo professor A. Dampf. (Diptera). - Memórias do Instituto Oswaldo Cruz 44(1): 119-146.

Lopes, H. S., 1950. Sobre os géneros *Boettcheria* Parker 1914 e *Boettcherimima* n. gen. (Diptera Sarcophagidae). - Memórias do Instituto Oswaldo Cruz 48: 687-709, 15 pls. [+ English translation pp. 711-732.]

Lopes, H. S., 1969a. Family Sarcophagidae. - In Papavero, N., ed. A catalog of the Diptera of the Americas south of the United States 103, 88 pp. Departamento de Zoologia, Secretaria da Agricultura. São Paulo.

Lopes, H. S., 1969b. Neotropical Sarcophagidae reared from Gastropoda by Dr. W. Weyrauch (Diptera). - Studia entomologica 12(1-4): 133-160.

Lopes, H. S., 1971a. Notes on Tephromyini, with description of a new species of *Mantidophaga* Townsend. - Revista brasileira de biologia 31(1): 3-13.

Lopes, H. S., 1971b. Notes on *Emblemasoma* and *Pessoamia* (Diptera, Sarcophagidae). - Revista brasileira de biologia 31(1): 89-97.

Lopes, H. S., 1972. *Borgmeierisca*, novo genero de Microcerellini do Brasil (Diptera, Sarcophagidae). - Studia entomologica 15(3/4): 345-352.

Lopes, H. S., 1973. Collecting and rearing sarcophagid flies (Diptera) in Brazil, during 40 years. - Anales de la Academia brasileira de Ciências 45(2): 279-291.

Lopes, H. S., 1974. Two new genera of Neotropical Sarcophagidae (Diptera). - Revista brasileira de biologia 33(2): 193-199.

Lopes, H. S., 1975a. Sarcophagid flies Diptera from Pacatuba, State of Ceará, Brazil. - Revista brasileira de biologia 34(2): 271-294.

Lopes, H. S., 1975b. On the types of some Sarcophagidae from Panama, described by H. R. Dodge (Diptera). - Revista brasileira de biologia 34(4): 511-522.

Lopes, H. S., 1975c. On female holotypes of some American species described by Francis Walker and J. Macquart (Diptera, Sarcophagidae, Calliphoridae). - Revista brasileira de biologia 34(4): 535-550.

Lopes, H. S., 1975d. Some new Sarcophagidae from Peru (Diptera). - Revista brasileira de biologia 34(4): 573-580.

Lopes, H. S., 1975e. On the types of some Neotropical Sarcophagidae described by Charles H. T. Townsend and David G. Hall (Diptera). - Revista brasileira de biologia 35(1): 45-58.

Lopes, H. S., 1975f. On some North American Sarcophagidae with red legs (Diptera). - Revista brasileira de biologia 35(1): 155-164.

Lopes, H. S., 1976. On the species of *Argoravinia* Town-

send (Diptera, Sarcophagidae). – Revista brasileira de biologia 36(3): 693-696.

Lopes, H. S., 1978a. On *Aulacophyto* Townsend and *Aulacophytooides* n. gen. (Diptera, Sarcophagidae). – Revista brasileira de biologia 38(4): 757-766.

Lopes, H. S., 1978b. On *Tripanurga albicans* (Diptera: Sarcophagidae). – Canadian Entomologist 110(11): 1141-1144.

Lopes, H. S., 1979. Contribution to the knowledge of the tribe Johnsoniini (Diptera, Sarcophagidae). – Revista brasileira de biologia 39(4): 919-942.

Lopes, H. S., 1980. On *Doringia* Weyenberg, *Xenoppia* Townsend and *Jujuyia* n. gen. (Diptera, Sarcophagidae, Microcerellini). – Revista brasileira de biologia 40(2): 231-240.

Lopes, H. S., 1981. On *Austrobartigia* (Diptera, Sarcophagidae, Microcerellini), with descriptions of seven new species. – Revista brasileira de biologia 41(2): 327-338.

Lopes, H. S., 1982a. Notes on American Sarcophagidae (Diptera) with descriptions of seven new species. – Revista brasileira de biologia 42(2): 285-294.

Lopes, H. S., 1982b. The genera of Microcerellini (Diptera, Sarcophagidae). – Revista brasileira de biologia 42(2): 359-369.

Lopes, H. S., 1982c. On some Microcerellini (Diptera, Sarcophagidae) with descriptions of four new species. – Revista brasileira de biologia 42(3): 489-498.

Lopes, H. S., 1982d. On Microcerellini (Diptera, Sarcophagidae) with four new species of *Boettia*. – Revista brasileira de biologia 42(3): 607-617.

Lopes, H. S., 1982e. The importance of the mandible and clypeal arch of the first instar larvae in the classification of the Sarcophagidae (Diptera). – Revista brasileira de entomologia 26(3/4): 293-326.

Lopes, H. S., 1988a. Notes on Neotropical Sarcophagidae (Diptera) with descriptions of a new genus and five new species. – Revista brasileira de biologia 48(2): 127-137.

Lopes, H. S., 1988b. On *Raviniopsis* (Diptera, Sarcophagidae) with descriptions of two new species. – Revista brasileira de biologia 48(2): 307-414.

Lopes, H. S., 1988c. On *Emblemasomini* (Diptera, Sarcophagidae), with descriptions of four new species. – Memórias do Instituto Oswaldo Cruz 83(1): 17-27.

Lopes, H. S., 1988d. On American Sarcophagidae (Diptera) with descriptions of a new genus and three new species. – Revista brasileira de biologia 48(4): 915-924.

Lopes, H. S. & R. Tibana, 1988. On Johnsoniini (Diptera, Sarcophagidae) with *Notochaetisca* new name, and descriptions of eight new species. – Revista brasileira de biologia 48(2): 315-332.

Macquart, J., 1851. Diptères exotiques nouveaux ou peu connus. Suite de 4.^{me} supplément publié dans les Mémoires de 1849. – Mémoires de la Société des Sciences, de l'Agriculture et des Arts de Lille [1850]: 134-294, 20 pls.

McAlpine, J. F., 1981. Morphology and terminology – adults. – Pp. 9-63 in McAlpine, J. F., B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth & D. M. Wood, eds. Manual of Nearctic Diptera, Vol. 1, Agriculture Canada, Monograph No. 27; vi + 1-674.

Neck, R. W. & H. S. Lopes, 1973. On some North American Sarcophagidae and Calliphoridae (Diptera) reared from Gastropoda. – Revista brasileira de biologia 33(2): 183-192.

Pape, T., 1987. The Sarcophagidae (Diptera) of Fennoscandia and Denmark. – Fauna entomologica scandinavica 19, 203 pp., 2 pls.

Pape, T., 1990. Two new species of *Sarcophaga* Meigen from Madeira and mainland Portugal (Diptera: Sarcophagidae). – Tijdschrift voor Entomologie 133: 39-42.

Pape, T., in press. Sarcophagidae (Diptera) from Makatea Island and Kwajalein Atoll. – Japanese Journal of Entomology.

Prado, A. & F. Fonseca, 1932. Um novo gênero e algumas novas espécies de sarcófagas (Diptera-Stephanostomatidae) da cidade de São Paulo. – Memórias do Instituto Butantan 7: 161-171.

Reinhard, H. J., 1945. New genera and species of muscoid flies. – Journal of the Kansas Entomological Society 18(2): 67-77.

Reinhard, H. J., 1947. New North American muscoid Diptera. – Journal of the Kansas Entomological Society 20(3): 95-116.

Reinhard, H. J., 1952. New North American muscoid Diptera. – Journal of the Kansas Entomological Society 20: 15-24.

Reinhard, H. J., 1963a. New American Sarcophagidae (Diptera). – Entomological News 74: 75-83.

Reinhard, H. J., 1963b. Correction (*Golcondamyia*, Tachinidae). – Entomological News 74: 152.

Roback, S. S., 1954. The evolution and taxonomy of the Sarcophaginae (Diptera, Sarcophagidae). – Illinois Biological Monographs 23(3/4): 1-181.

Rohdendorf, B. B., 1971. On the Sarcophagidae from Cuba. – Casopis Moravského musea v Brně 55: 89-114.

Rondani, C., 1864. Dipterorum species et genera aliqua revisa et annotata, novis nonnullis descriptis. – Archivos Zoologia Anatomica di Canestrini 3: 1-99, 5 pls.

Sabrosky, C. W., 1983. A synopsis of the world species of *Desmometopa* Loew (Diptera, Milichiidae). – Contributions of the American Entomological Institute 19(8): 1-69.

Séguy, E., 1925. Sur le *Microcerella rufomaculata* Macq. – Encyclopédie entomologique Ser. B, II, Diptera 4: 184.

Shewell, G. E., 1987. Sarcophagidae. – Pp. 1159-1186 in McAlpine, J. F., ed. . Manual of Nearctic Diptera. Vol. 2. Research Branch, Agriculture Canada, Monograph 28, vi + 675-1332.

Shinonaga, S. & R. A. Beaver, 1979. *Pierretia urceola*: a new species of sarcophagid fly found living in *Nepenthes* pitcher plants in West Malaysia. – Annales de la Société Entomologique de France 15(1): 37-40.

Silvestri, F., 1903. Contribuzione alla conoscenza dei termitidi e termitofili dell'America meridionale. – Redia 1: 1-234, 6 pls.

Soper, R. S., G. E. Shewell & D. Tyrell, 1976. *Colcondomyia auditrix* nov. sp. (Diptera: Sarcophagidae), a parasite which is attracted by the mating song of its host, *Okanagana rimosa* (Homoptera: Cicadidae). – Canadian Entomologist 108: 61-68.

Thomson, C. G., 1869. 6. Diptera. Species nova descriptit. – Pp. 443-614, pl. 9. In: Kungliga Svenska vetenskapsakademien, Kongliga svenska fregatten Eugenies resa omkring jorden. Pt. 2: Zoologie, 1: Insekter, 617 pp, 9 pls.

Tibana, R. & H. S. Lopes, 1988. On *Aulacophyto* and *Euparaphyto* (Diptera, Sarcophagidae, Microcerellini), with descriptions of four new species. – Memórias do Instituto Oswaldo Cruz 82(3): 371-378.

Townsend, C. H. T., 1912. Descriptions of new genera and species of muscoid flies from the Andean and Pacific coast regions of South America. – Proceedings of the United States National Museum 43: 301-367.

Townsend, C. H. T., 1915. Proposal of new muscoid

genera for old species. – Proceedings of the Biological Society of Washington 28: 19-23.

Townsend, C. H. T., 1916. Designations of muscoid genotypes, with new genera and species. – Insecutor Inscitiae Menstruus 4: 4-12.

Townsend, C. H. T., 1917a. New genera and species of American muscoid Diptera. – Proceedings of the Biological Society of Washington 30: 43-50.

Townsend, C. H. T., 1917b. Genera of the dipterous tribe Sarcophagini. – Proceedings of the Biological Society of Washington 30: 189-197.

Townsend, C. H. T., 1918. New genera of Amobiinae (Diptera). – Insecutor Inscitiae Menstruus 5: 157-165.

Townsend, C. H. T., 1919. New muscoid genera, species and synonymy (Diptera). – Insecutor Inscitiae Menstruus 6: 157-182.

Townsend, C. H. T., 1927. Synopse dos genero muscoideos da regio humida neotropical da America, com generos e especies novas. – Revista do Museu paulista 15: 203-385, 4pls, 4pp errata.

Townsend, C. H. T., 1931. Notes on American oestromuscoid types. – Revista de entomologia 1: 65-104.

Townsend, C. H. T., 1934. New Neotropical oestromuscoid flies. – Revista de entomologia 4: 201-212.

Townsend, C. H. T., 1937a. Two new South American oestromuscarian genera (Diptera). – Revista de entomologia 7: 115-117.

Townsend, C. H. T., 1937b. Manual of myiology. Part V. Muscoid generic diagnoses and data. Glossinini to Agriini. – Itaquaquecetuba, São Paulo. 234 pp.

Townsend, C. H. T., 1938. Manual of myiology. Part VI. Muscoid generic diagnoses and data. Stephanostomatini to Moriniini. – Itaquaquecetuba, São Paulo. 309 pp.

Verves, Yu. G., 1986. Family Sarcophagidae. – Pp. 58-193 in: Soós, A. & L. Papp, eds. Catalogue of Palaearctic Diptera. Vol. 12, Calliphoridae-Sarcophagidae. 265 pp.

Weyenbergh, H., 1875. Animales utiles. *Nemorea acridorum* Weyenb. – Anales Agricultura de la Republica Argentina 3(9): 85-86.

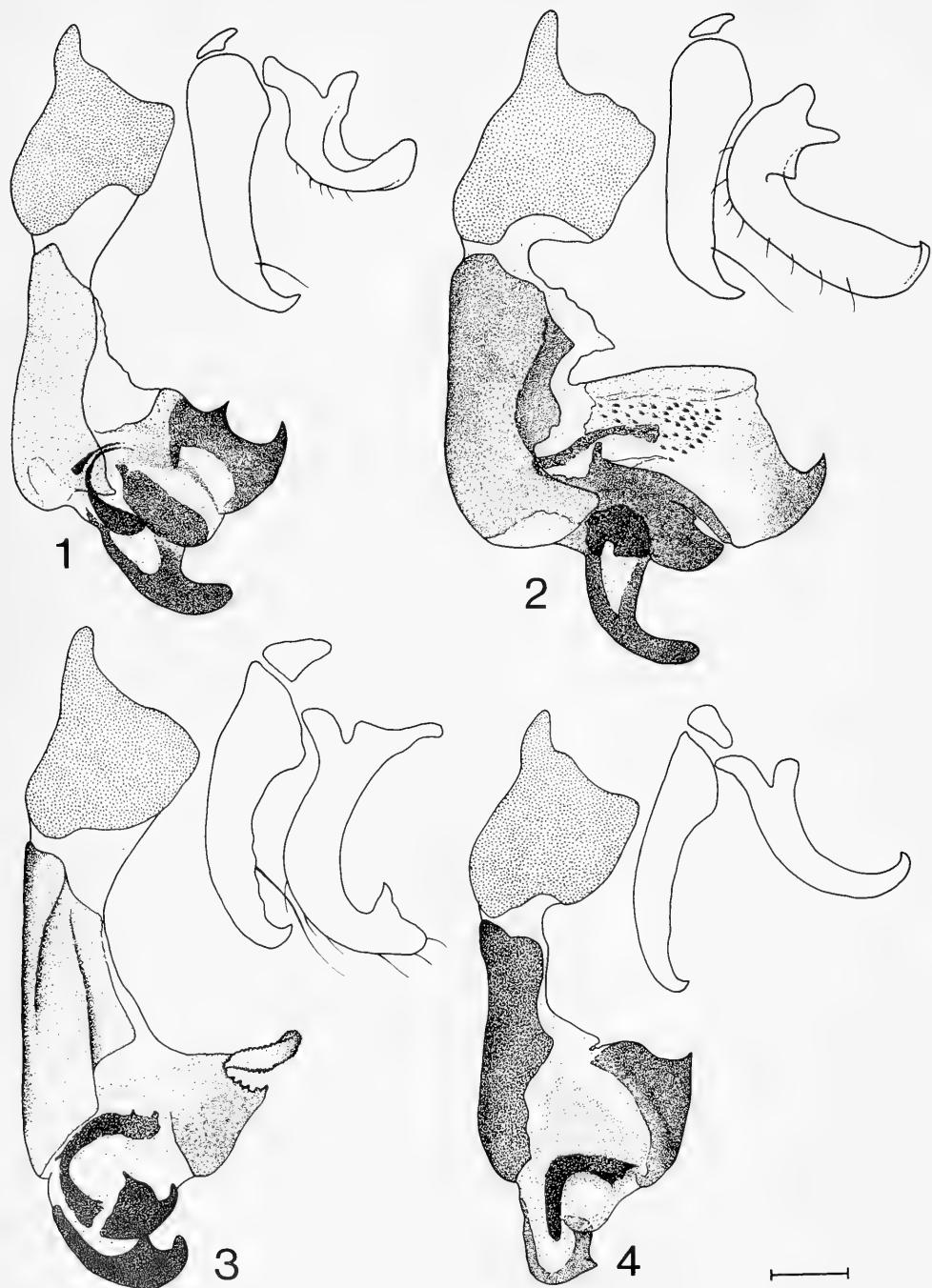
Wiedemann, C. R. W., 1830. Aussereuropäische zweiflügelige Insekten. Vol. 2. – Hamm. 684 pp., 5 pls.

Williams, R. W., 1958. A study of the summer filth fly population of the Bermuda Islands. – Journal of Parasitology 44(3): 339-342.

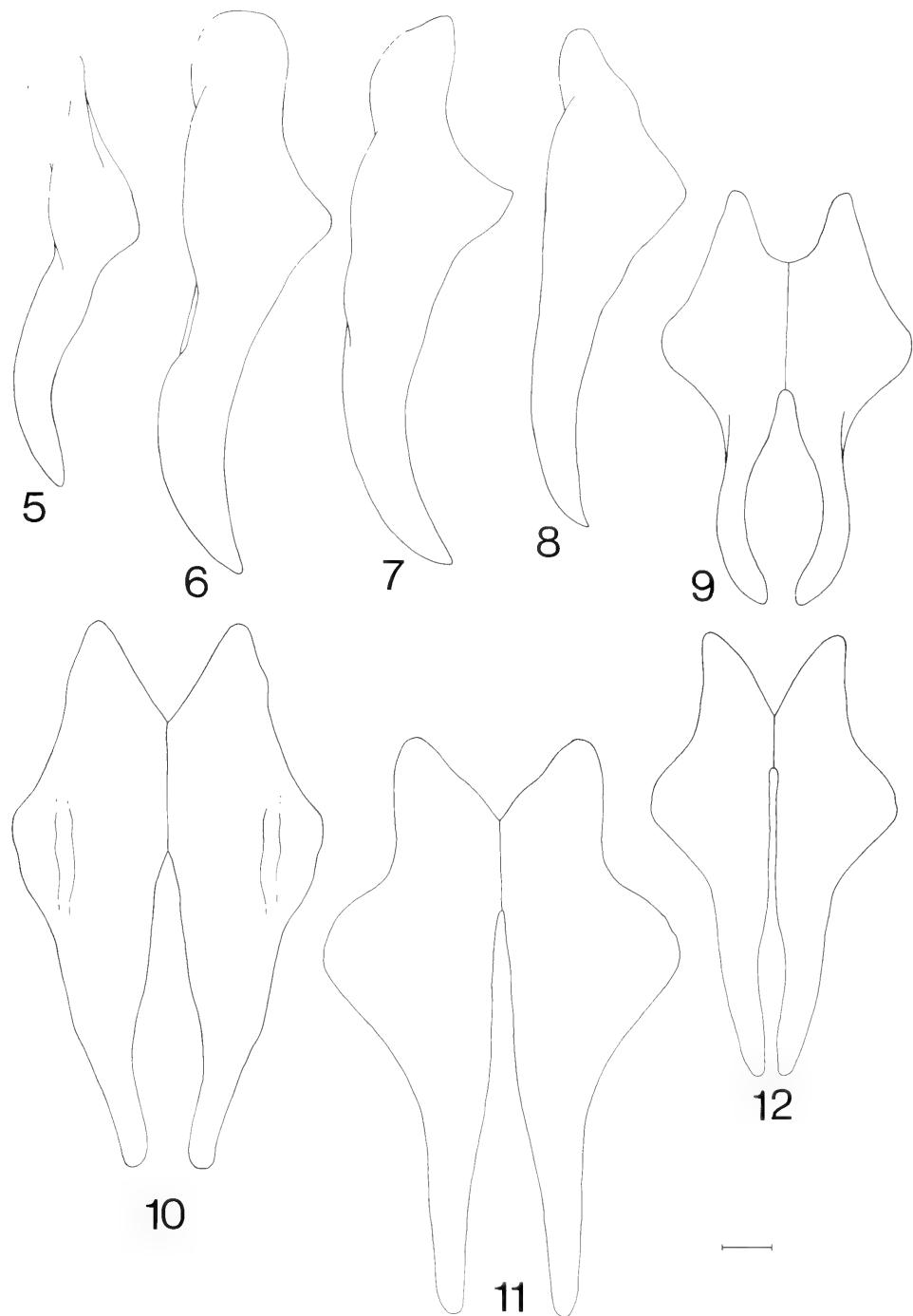
Williams, R. W., 1959. The reported biting and filth frequenting arthropods of the Bermuda Islands exclusive of the Ixodidae and Araneida. – Proceedings of the Entomological Society of Washington 61(5): 234-238.

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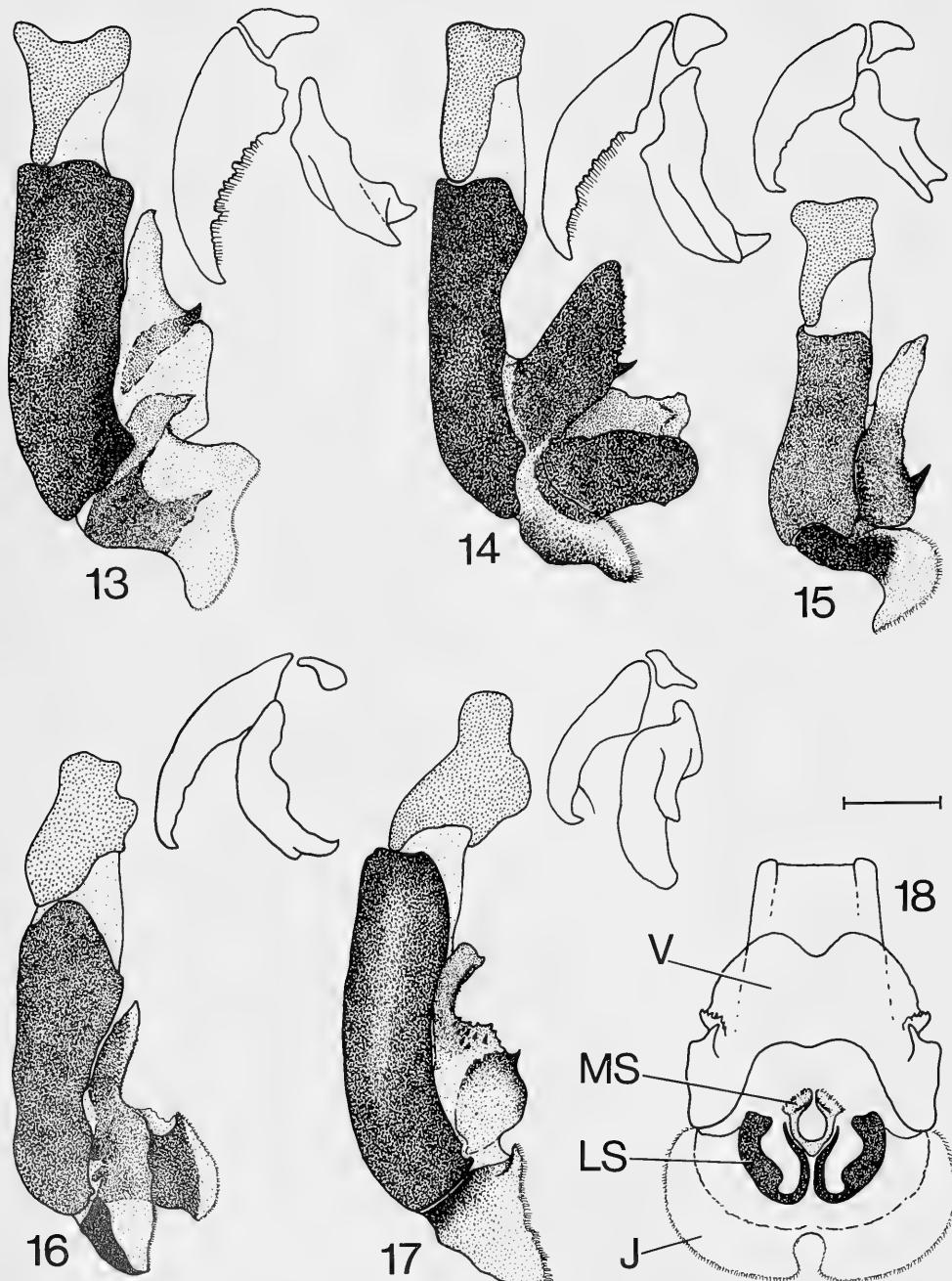
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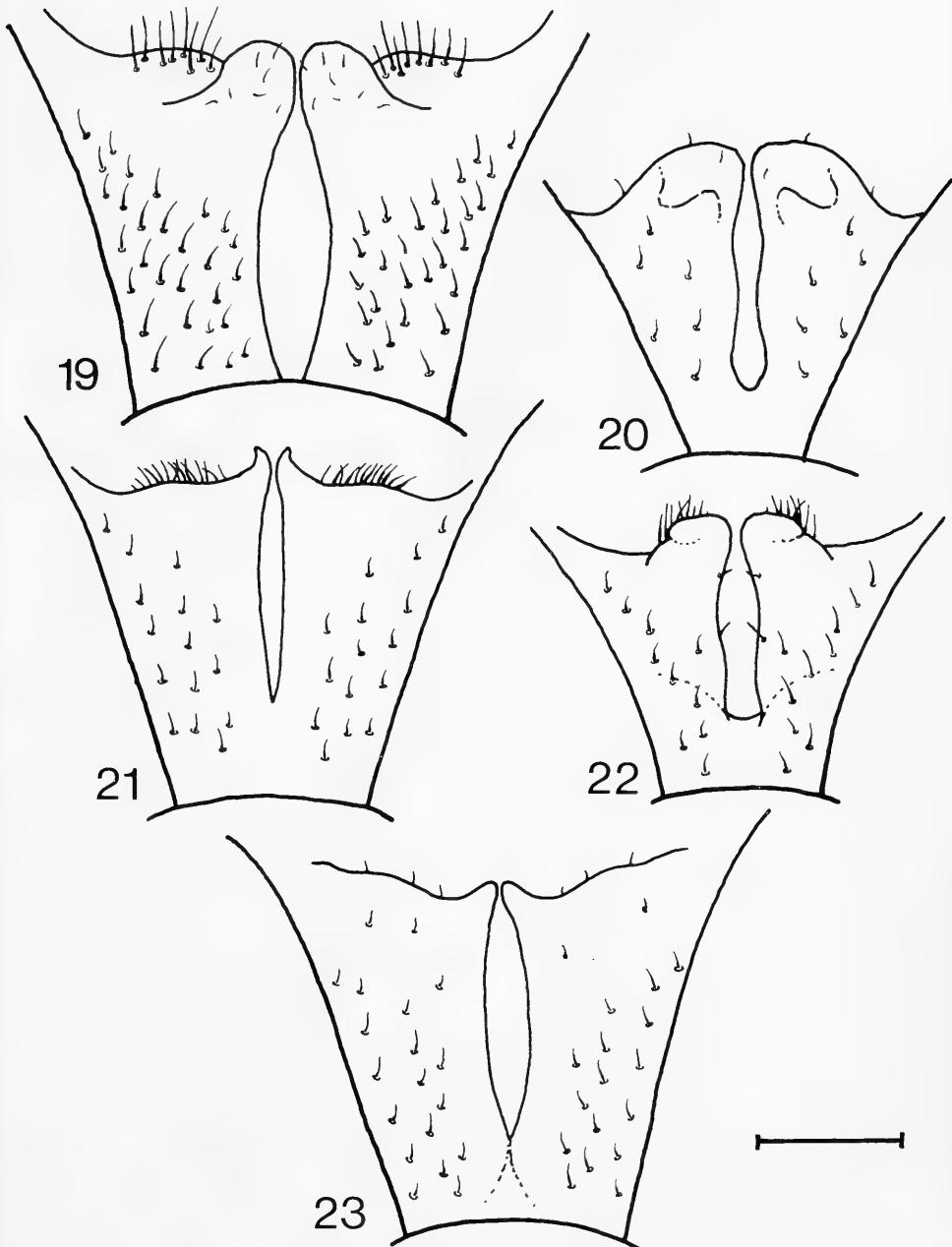
Figs. 1-4. *Comasarcophaga* spp. Aedeagus plus right paramere + gonopod, lateral view. 1, *C. longespinus*. 2, *C. prolepsis*. 3, *C. texana*. 4, *C. nexilis*. Scale: 0.1 mm.



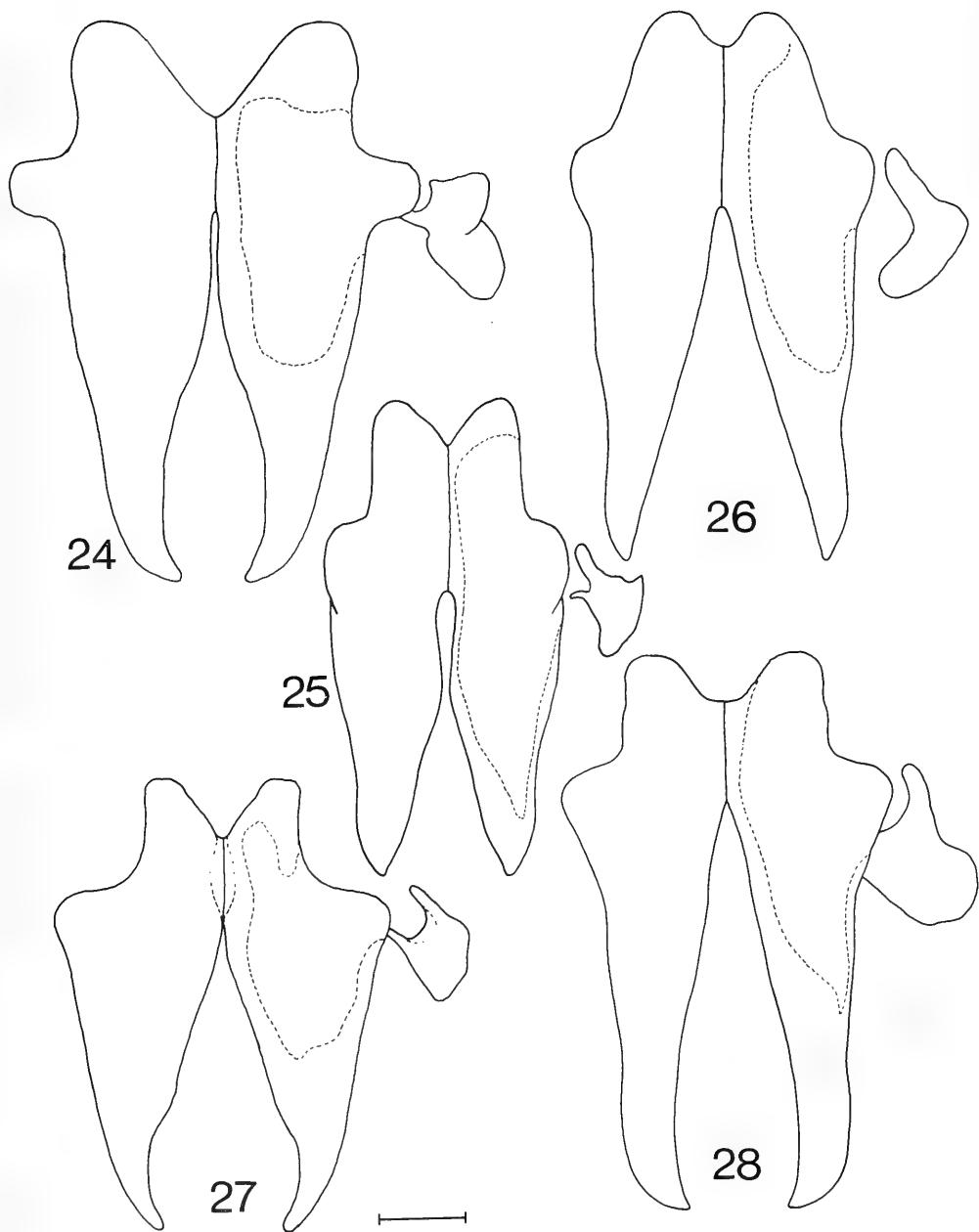
Figs. 5-12. *Comasarcophaga* spp. Male cerci. Figs. 5-8, right cercus, lateral view. Figs. 9-12, cerci, posterior view. 5, 9, *C. longespinus*. 6, 10, *C. prolepsis*. 7, 11, *C. texana*. 8, 12, *C. nexilis*. Scale: 0.1 mm.



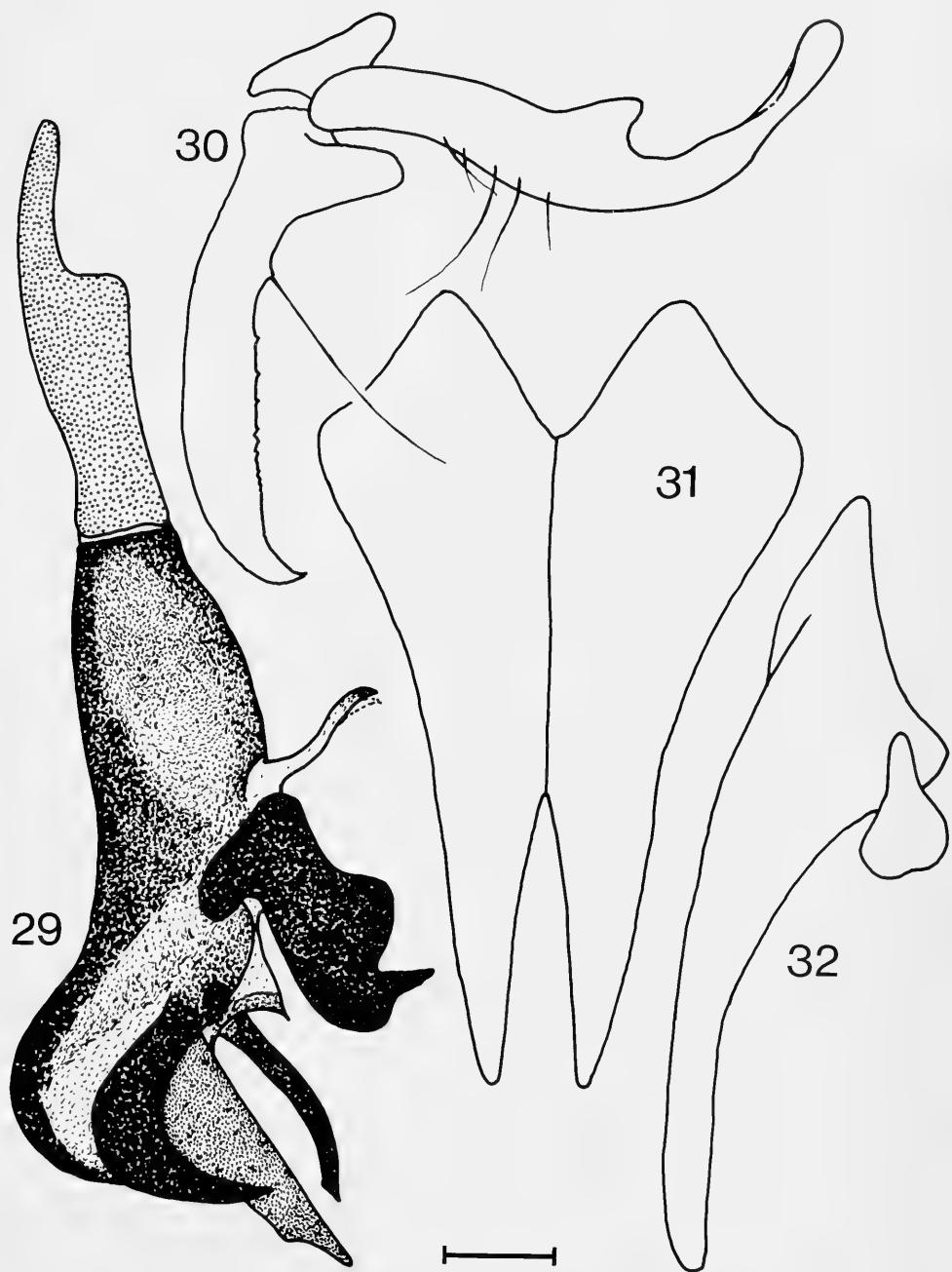
Figs. 13-18. *Fletcherimyia* spp. Figs. 13-17, aedeagus plus right paramere + gonopod, lateral view. Fig. 18, distiphallus, ventral view. 13, *F. abdita*. 14, *F. celarata*. 15, *F. fletcheri*. 16, *F. jonesi*. 17, 18, *F. rileyi*. Abbreviations: J = juxta, LS = lateral stylus, MS = median stylus, V = vesica. Scale: 0.2 mm.



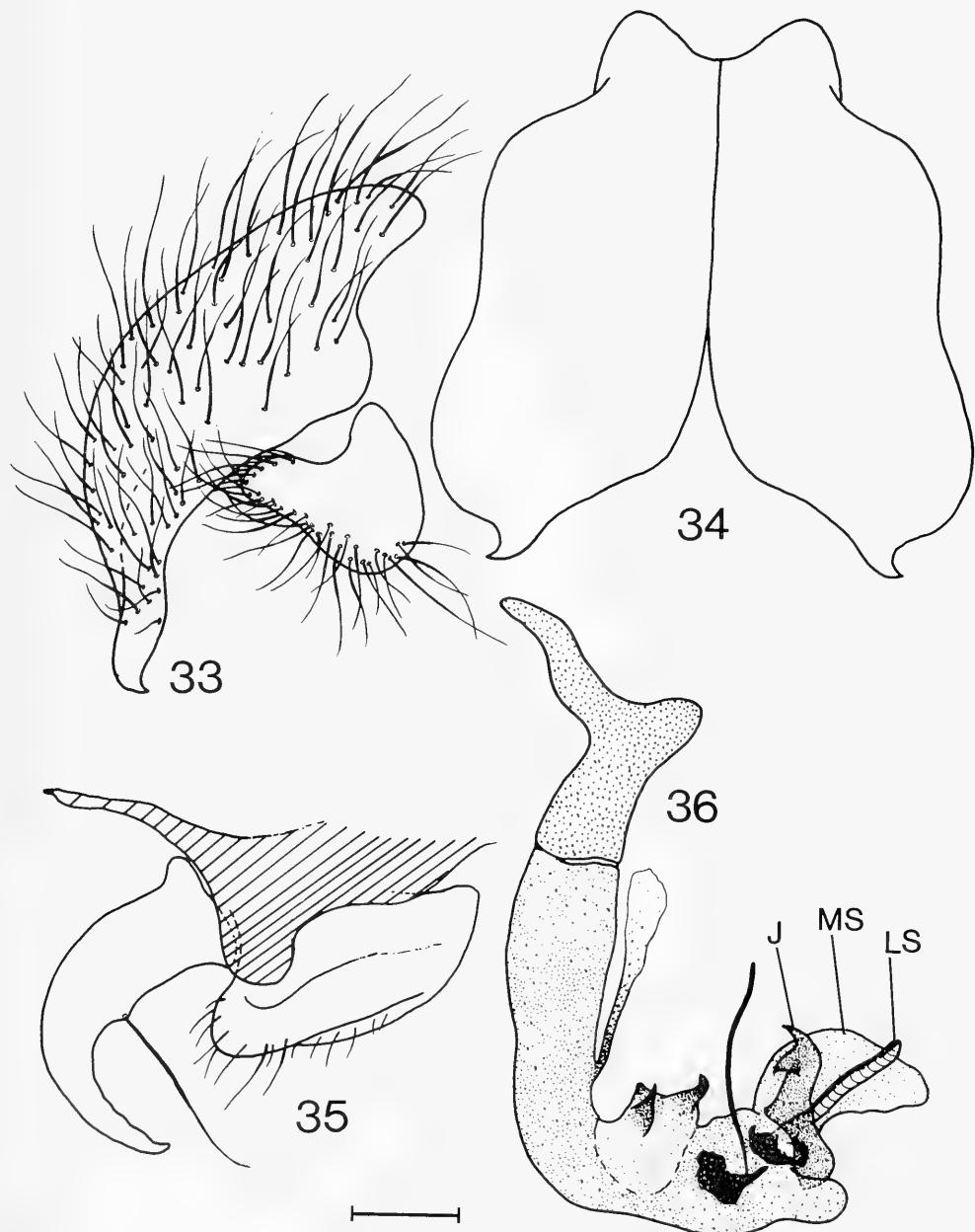
Figs. 19-23. *Fletcherimyia* spp. Male abdominal sternite 5, as seen from below between sternite 4 and margins of tergite 5. 19, *F. abdita*. 20, *F. celarata*. 21, *F. fletcheri*. 22, *F. jonesi*. 23, *F. rileyi*. Scale: 0.4 mm.



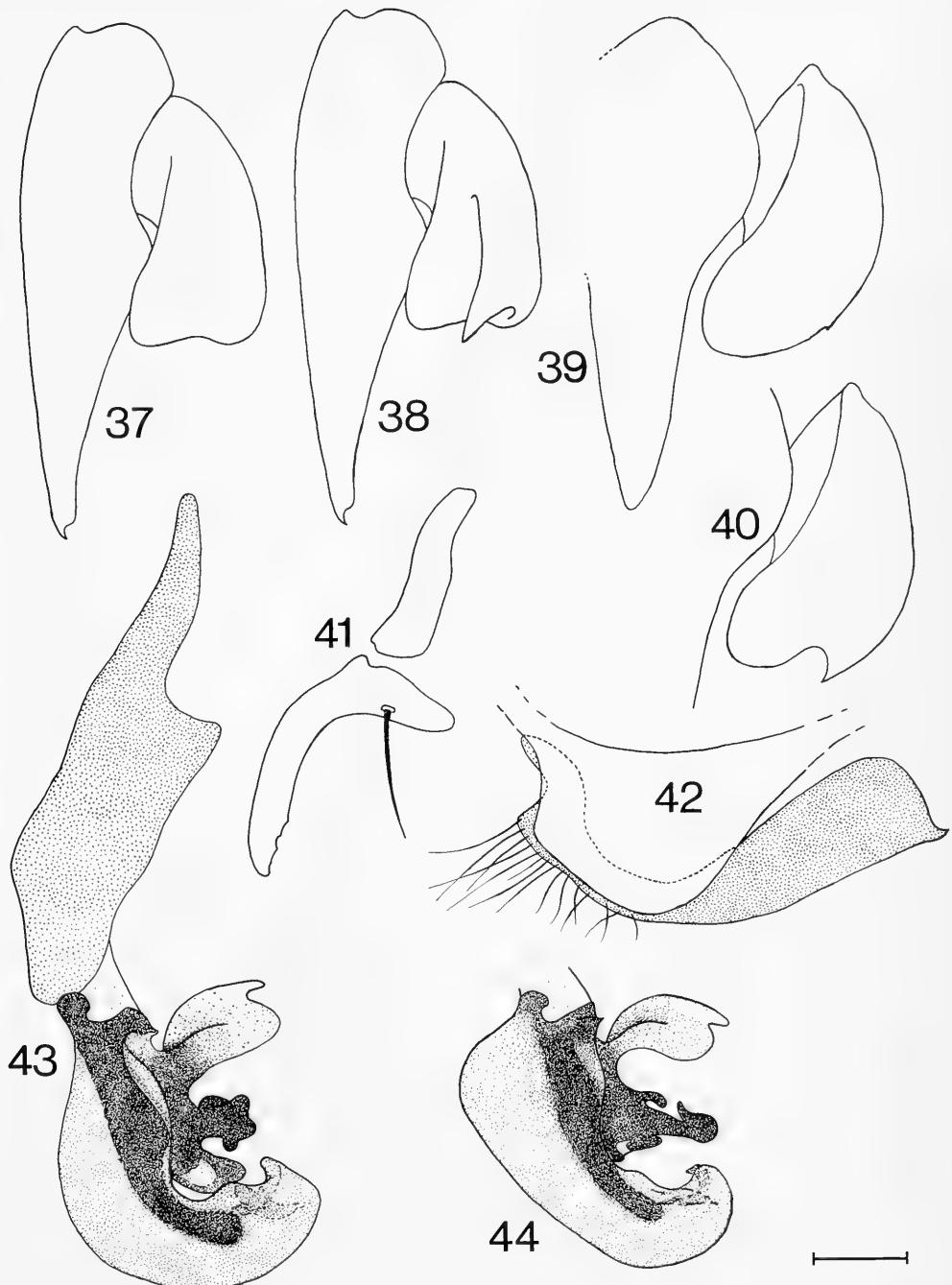
Figs. 24-28. *Fletcherimyia* spp. Outline of male cerci + right surstylus, posterior view. Dotted line on right cercus delimit area devoid of setae. 24, *F. abdita*. 25, *F. jonesi*. 26, *F. celarata*. 27, *F. fletcheri*. 28, *F. rileyi*. Scale: 0.2 mm.



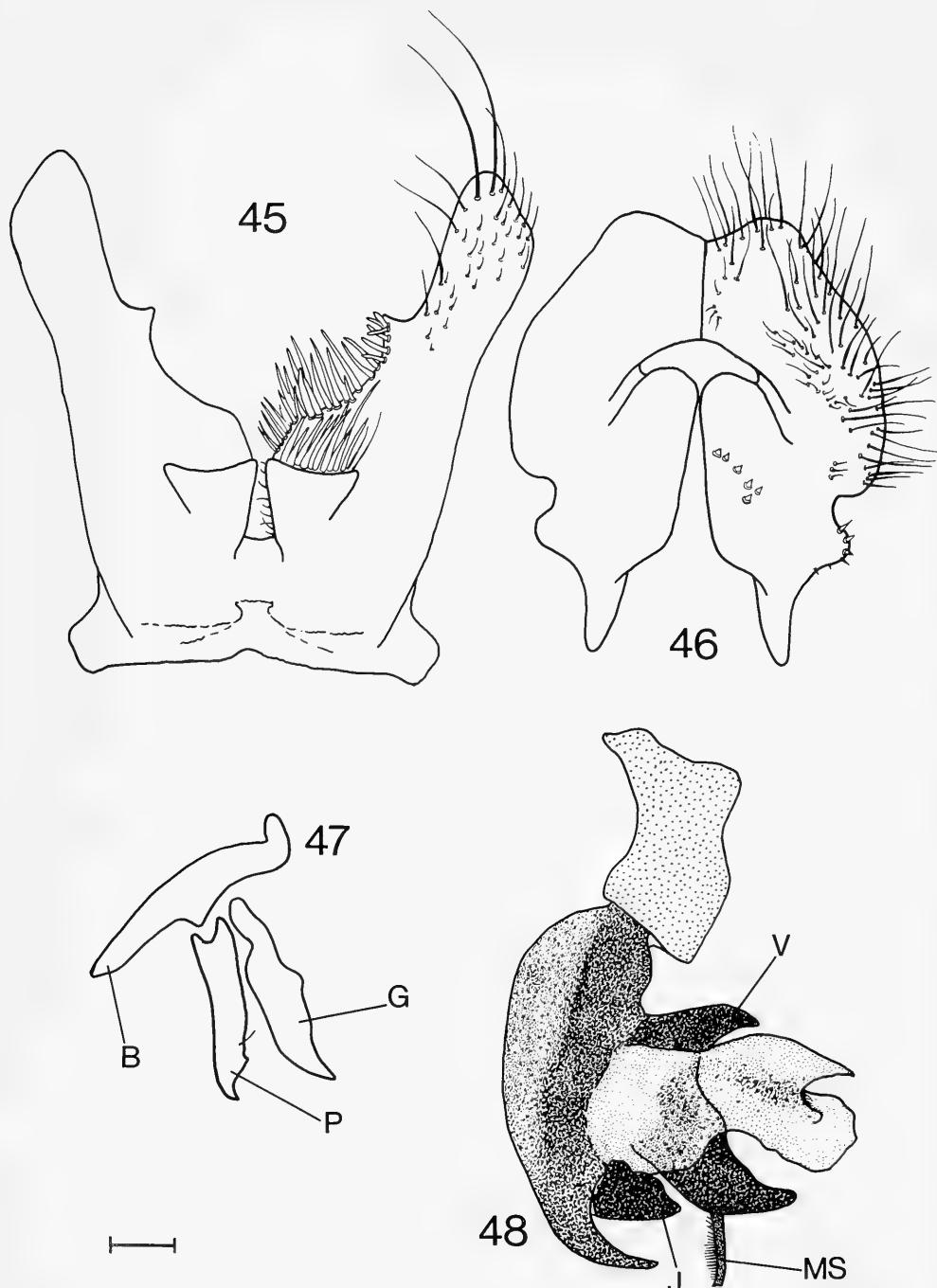
Figs. 29-32. *Microcerella acridorum*. Male terminalia. 29, Aedeagus, lateral view, 30, Right paramere + gonopod, lateral view, 31, Outline of cerci, posterior view. 32, Outline of right cercus + surstylius, lateral view. Scale: 0.2 mm.



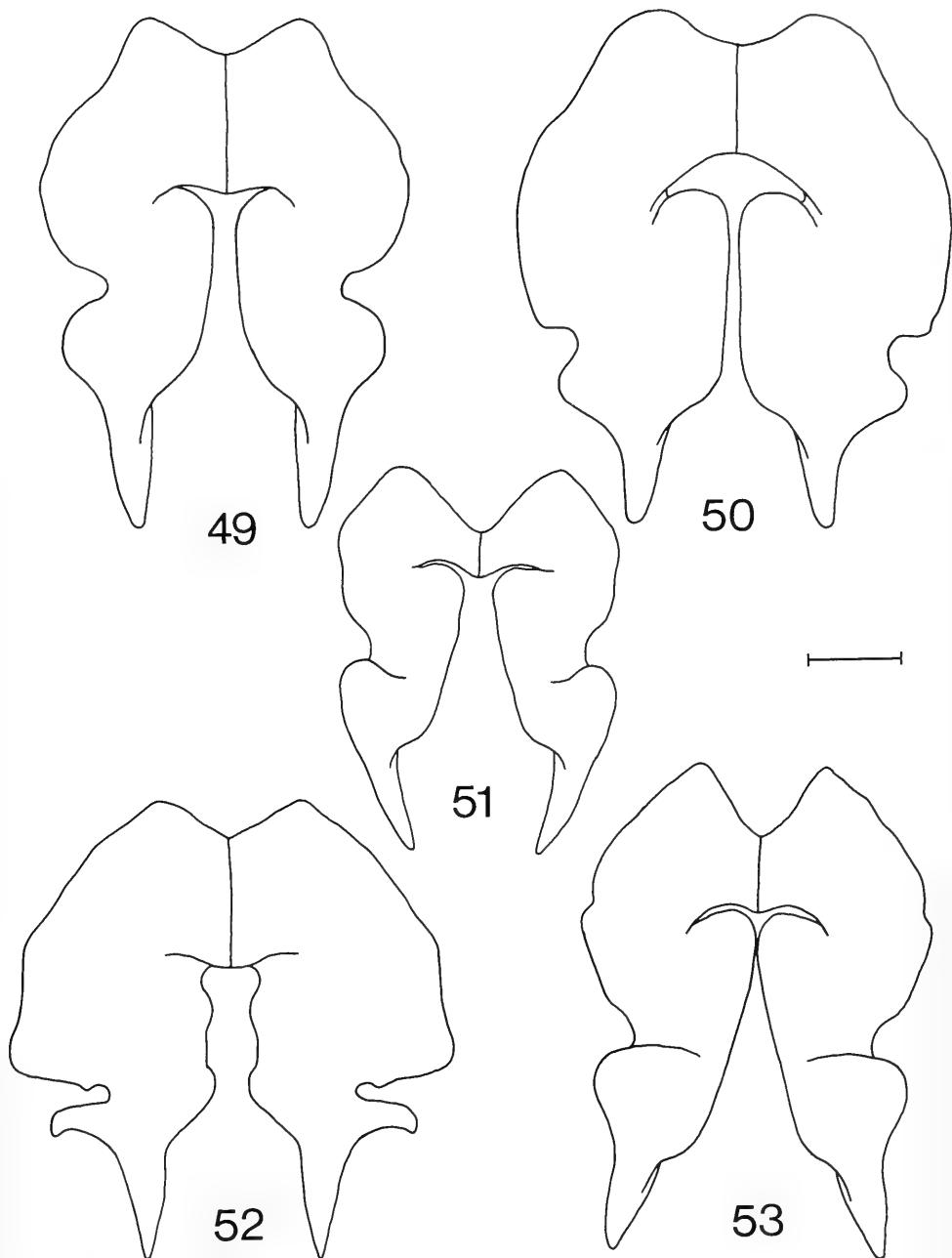
Figs. 33-36. *Microcerella bermuda*. Male terminalia. 33, Right cercus + surstylus, lateral view. 34, Outline of cerci, posterior view. 35, Right paramere + gonopod, lateral view, plus posterior end of right hypandrial arm (hatched). 36, Aedeagus, lateral view. Abbreviations: J = juxta, LS = lateral styli, MS = median stylus. Scale: 0.1 mm.



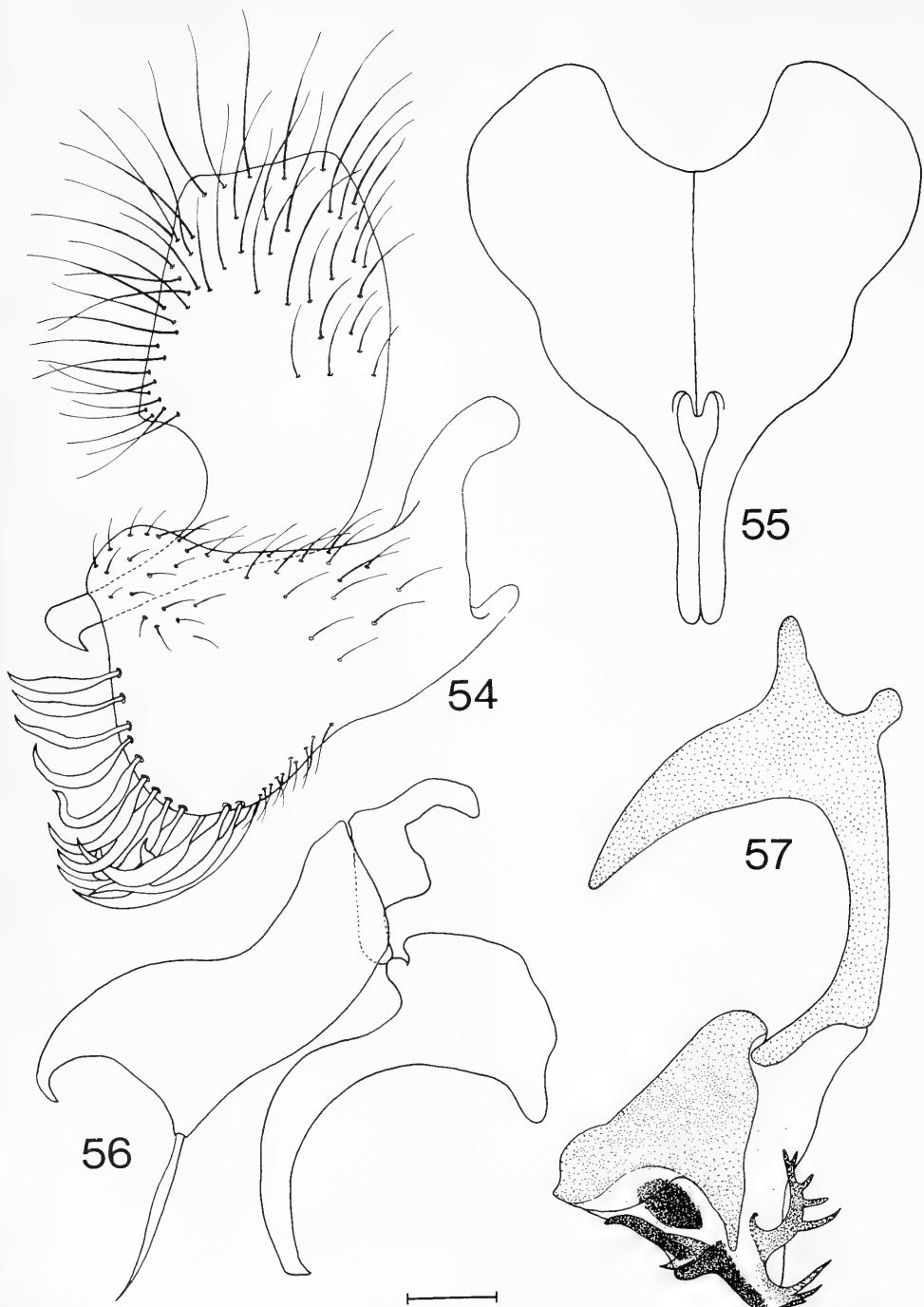
Figs. 37-44. *Microcerella* spp. Male terminalia. Figs. 37, 39, 44, *M. scrofa*. Figs. 38, 40-43, *M. adelphe*. 37, right cercus + surstylius, lateral view. 38, right cercus + surstylius, lateral view. 39, right cercus (in part) + surstylius, posterior view. 40, right cercus (in part) + surstylius, posterior view. 41, paramere. 42, right gonopod (stippled) and posterior part of hypandrial arm, lateral view. Fig. 43, aedeagus. Fig. 44, distiphallus. Scale: 0.1 mm.



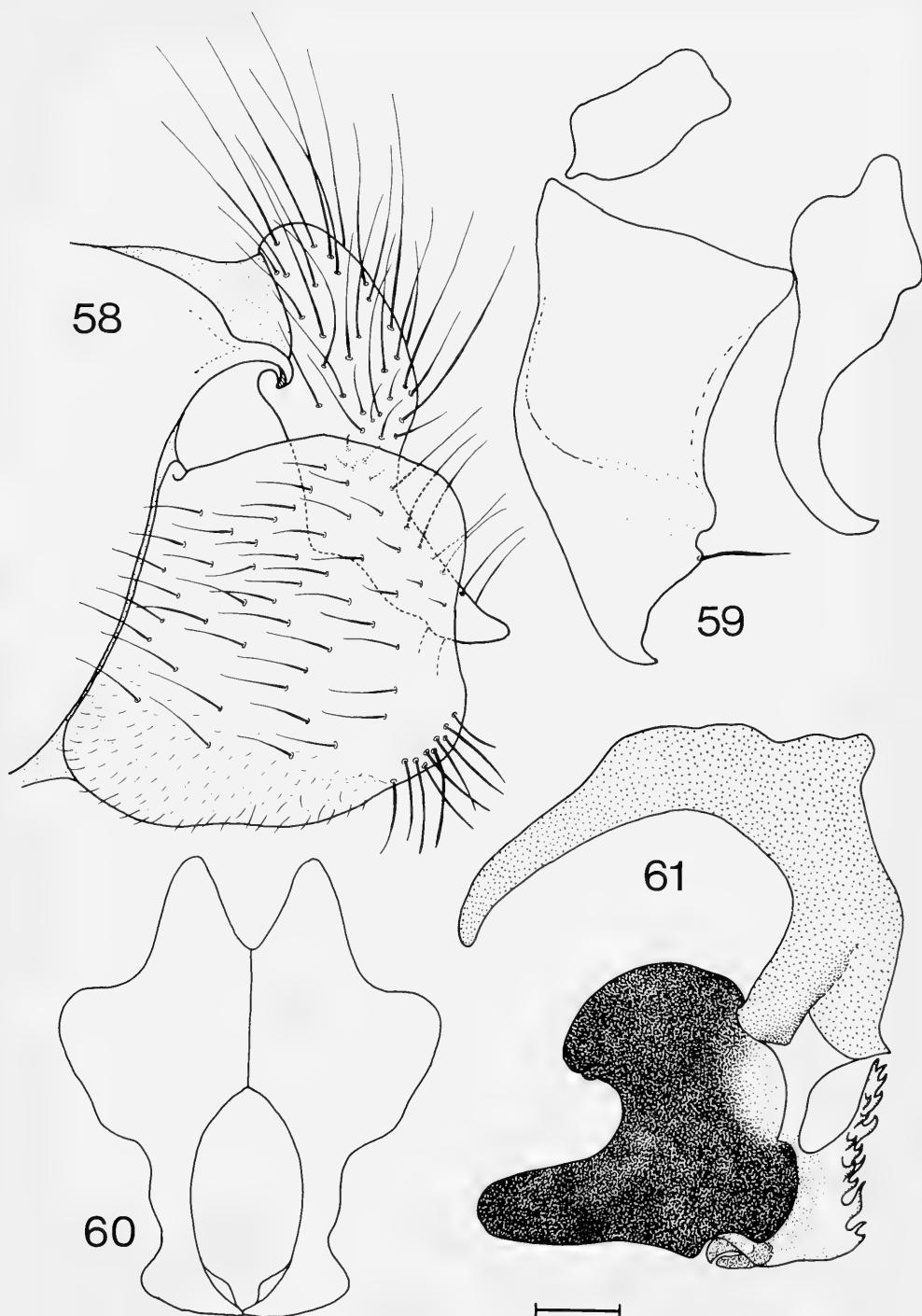
Figs. 45-48. *Spiroboflya latissima*, male terminalia. 45, Abdominal sternite 5, ventral view. 46, Cerci, posterior view, setae of left cercus omitted. 47, Right paramere + gonopod, lateral view. 48, Aedeagus. Abbreviations: B = basal parameral sclerite, G = gonopod, J = juxta, MS = median stylus, P = paramere, V = vesica. Scale: 0.2 mm.



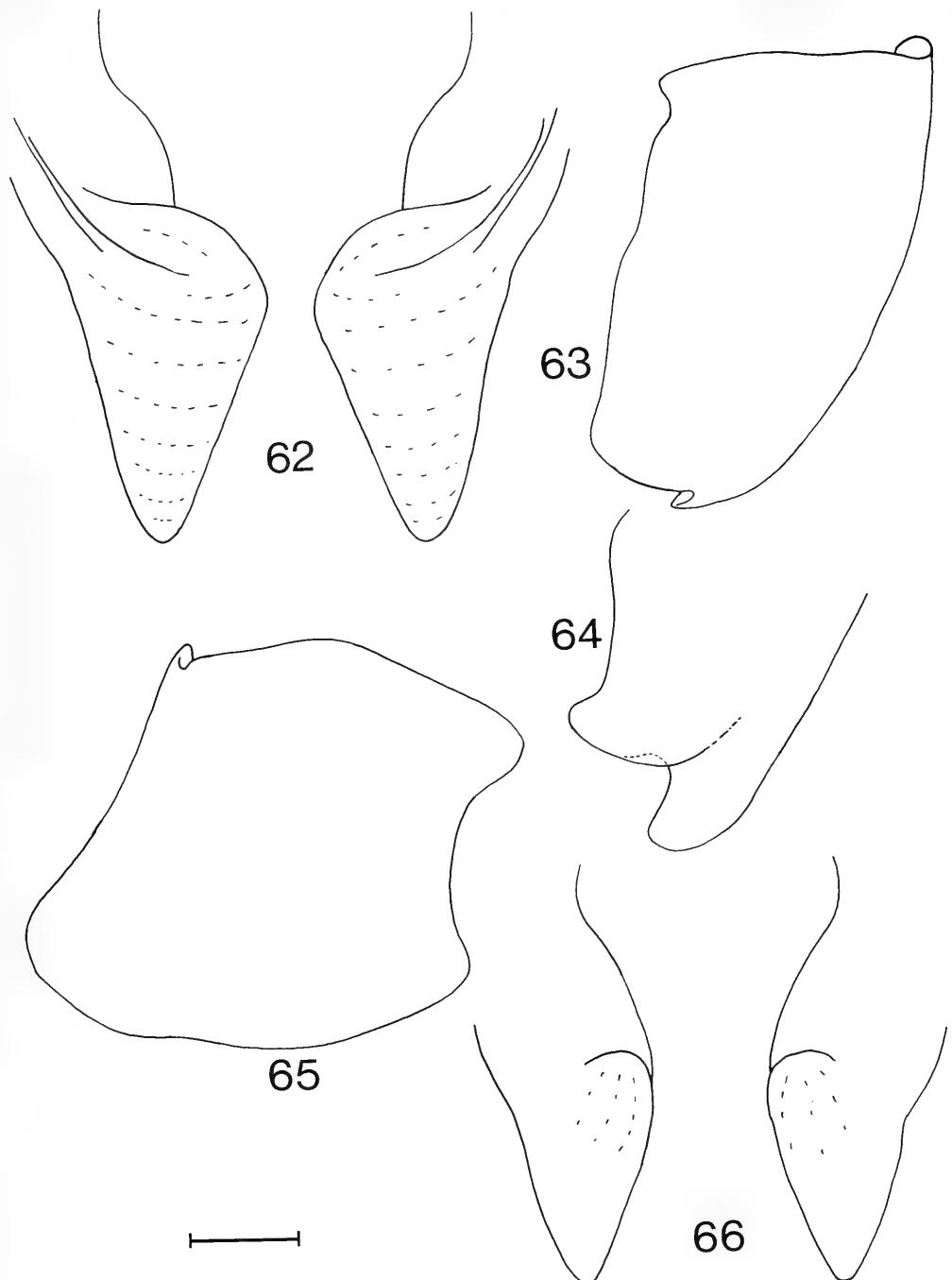
Figs. 49-53. *Spiroboomyia* spp., outline of male cerci, posterior view. 49, *S. ohioensis*. 50, *S. latissima*. 51, *S. basalis*. 52, *S. singularis*. 53, *S. flavipalpis*. Scale: 0.2 mm.



Figs. 54-57. *Tripanurga guattemala*, male terminalia. 54, Right cercus + surstyli. 55, Outline of cerci. posterior view. 56, Right paramere + gonopod, lateral view. 57, Aedeagus. Scale: 0.1 mm.



Figs. 58-61. *Tripanurga aurea*, male terminalia. 58, Left cercus + surstylius, lateral view. 59, Right paramere + gonopod, lateral view. 60, Outline of cerci, posterior view. 61, Aedeagus, lateral view. Scale: 0.1 mm.



Figs. 62-66. *Tripanurga aurea*, Details of male terminalia. Figs. 62, 63, Baja Californian form. Figs. 64-66, mainland form. 62, Lobes of abdominal sternite 5, posterior view. 63, Right surstyli, posterior view. 64, Distal part of right surstyli, posterior view. 65, Outline of left surstyli, lateral view. 66, Lobes of abdominal sternite 5, posterior view. Scale: 0.1 mm.

SEVEN NEW SPECIES OF ELACHISTIDAE (LEPIDOPTERA) FROM THE USSR

Sruoga, V., 1990. Seven new species of Elachistidae (Lepidoptera) from the USSR. Tijdschrift voor Entomologie 133: 75-84, figs. 1-26. [ISSN 0040-7496]. Published 31 July 1990. Seven new species of Elachistidae are described from Tadzhikistan and Turkmeniya (Soviet Central Asia) and Primorskiy Kray (Soviet Far East). They belong to the genera *Perittia* Stainton, *Elachista* Treitschke, *Biselachista* Traugott-Olsen & Nielsen and *Cosmiotes* Clemens. The male external features and genitalia are described and figured in detail. The distribution is mapped. A historical review of studies on USSR Elachistidae is provided in the introduction.

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Keywords. – Elachistidae, new species, USSR, Central Asia, Primorskiy Kray.

INTRODUCTION

Elachistidae larvae are typically leafminers of herbaceous, monocotyledonous plants, belonging to the families Poaceae, Cyperaceae and Juncaceae. Some species are leafminers of herbaceous dicotyledons belonging to the Boraginaceae, Lamiaceae, Asteraceae and Cistaceae (Traugott-Olsen & Nielsen 1977). Only in a few cases Elachistidae larvae mine leaves of woody Caprifoliaceae (*Lonicera*). Elachistidae larvae form galleries or blotches between the upper and lower epidermis layers and feed on the green parenchyma. The adult moths are small, with a wingspan of 6 to 13 mm. The forewings of the majority of species are brownish-grey with one fascia or two fasciae. Some Elachistidae are unicolorous brown, white or cream.

The family is widely distributed. However, revisions of Elachistidae are only published for the Nearctic fauna (Braun 1948) and the North European fauna (Traugott-Olsen & Nielsen 1977).

The last decade a considerable number of taxonomic papers has been published with descriptions of new species from western and central Europe, northern Africa, the Canary Islands, western and central Asia (Parenti 1978, 1981, Traugott-Olsen 1985a, 1985b, 1988, Nielsen & Traugott-Olsen 1978b, 1981, 1987, Whitebread 1984) and also from Japan (Kuroko 1982, Parenti 1983). The Elachistidae fauna of the USSR has been poorly studied. In the "Keys to the insects of the European part of the USSR" (Falkovitsh 1981) 77 species of Elachistidae have been treated, including figures of their genitalia. This key was entirely based on Traugott-Olsen & Nielsen's book (1977) on the Fennoscandian and Danish fauna, and did not provide original data on Elachistidae from the USSR territories.

As early as the mid-19th century, five species of Elachistidae were recorded from Latvia, i.e. *Elachista quadripunctella* (Hübner), *E. luticomella* Zeller, *E. pollinariella* Zeller, *E. albifrontella* (Hübner) and *E. argentella* (Clerck) (Lienig 1846). Nine other species were added by Nolcken (1871), i.e. *Elachista regificella* Sircom, *E. humiliis* Zeller, *E. pulchella* (Haworth), *E. bisulcella* (Duponchel), *E. cerusella* (Hübner), *E. gleichenella* (Fabricius), *Biselachista serricornis* (Stainton), *B. utorella* (Frey) and *B. albidella* (Nylander). Nolcken (1871) also recorded 16 species for the Estonian fauna. Twenty-four species were included in the Catalogue of Russian Lepidoptera by Ershov & Fild (1870). Teich (1889, 1893, 1899) recorded five additional species of Elachistidae for the Baltic fauna: *Elachista eleochariella* Stainton, *E. pullicomella* Zeller, *E. biatomella* Stainton, *E. dispilella* Zeller and *Cosmiotes freyerella* (Hübner). The Estonian entomologist Petersen (1924) mentioned 25 species for the Estonian fauna, four of which (*Elachista apicipunctella* Stainton, *E. megerella* Stainton, *E. poae* Stainton and *E. pomerana* Frey) were recorded for the first time for the eastern baltic region (the present Baltic republics). Some additional data on the Baltic Elachistidae were provided by Saar (1930), Palionis (1932), Brandt (1942), Prüffer (1947) and Kuusik (1962). Elachistidae from other eastern European regions are dealt with by Schille (1931): he noted 32 species from eastern Poland (now parts of the Ukraine).

In recent years investigations on Elachistidae of various regions in the USSR (including the Baltic republics) have been intensified. Šulcs & Šulcs (1983, 1984, 1987), Savenkov (1984, 1987) and Ivinskis et al. (1985) recorded 48 species of Elachistidae for the three Baltic republics, and two more

species will be added shortly (N. Savenkov pers. comm.). From other regions of the European part of the USSR the studies in the Vyborg reserve near Leningrad are worth mentioning: 17 Elachistidae were recorded here (Sukhareva & Falkovitsh 1984). Further, Sinev (1988) found two species, *Elachista nielswolffi* Svensson and *Cosmiotes exactella* Hertig-Schäffer, in the Murmansk region in 1979–1980, amongst a considerable number of Lepidoptera species. Material of the Crimean Elachistidae is still under study (Yu. Budashkin pers. comm.).

Hitherto, only one work dealt with the Elachistidae of the Asiatic part of the USSR (Falkovitsh 1986), in which one new genus (*Kumia* Falkovitsh) and three new species (*Kumia integrata*, *Elachista ilicina* and *E. manca*) were described.

From this review it is clear that the Elachistidae fauna of the USSR is very imperfectly known, and further studies are urgently needed for a better understanding of this rich and interesting fauna.

This paper contributes with the description of seven new species from two regions in the Asiatic part of the USSR.

MATERIAL AND METHODS

Methods for preparation of genitalia largely follow Falkovitsh & Stekolnikov (1978). The genitalia of the *Cosmiotes* species are figured here with the valvae *in situ*, because of difficulties in spreading them without damage. The genitalia were studied with a Biolam microscope and a MBS-10 stereomicroscope, using the drawing apparatus according to Gorodkov (1961) for the line figures.

The material studied has been collected during expeditions to largely unexplored and little known areas of Soviet Central Asia. In addition material from Tadzhikistan and Primorskiy Kray collected by R. Puplesis in 1982 to 1986 has been studied.

Locality names are spelled in accordance with the Times Atlas of the World (comprehensive edn. 1975 and later).

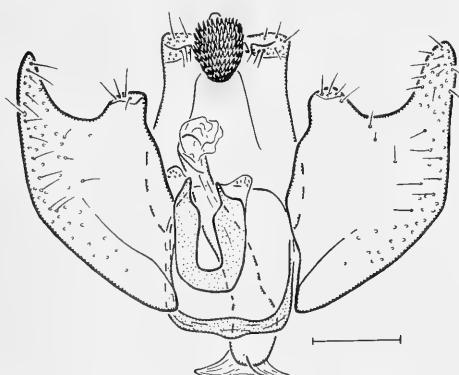


Fig. 1. *Perittia biloba*, holotype: male genitalia. Scale 0.1 mm.

The type specimens are deposited in the collection of the "Minology" working group, Department of Zoology, Pedagogical Institute, Vilnius, Lithuania (MG) and in the collections of the Zoological Institute of the USSR Academy of Sciences in Leningrad (ZIAS).

TAXONOMY

Perittia biloba sp. n. (figs. 1, 25)

Type material. — Holotype ♂: USSR, Tadzhikistan, 30 km N Dushanbe, env. Varzob (Kondara), 27.vi.1986, R. Puplesis (MG).

Diagnosis. — Related to *P. lonicerae* (Zimmerman & Bradley), distinguished from this species by the shape of the valvae and juxta, the basal part of the aedeagus and the shape of the tegumen.

External characters. — Male (female unknown). Forewing length 3.0 mm. Frons, neck tufts and scape white, some brown scales. Antenna white and brown ringed. Labial palp slightly mottled by white and brownish scales. Thorax and tegulae strongly mottled by white and brown scales. Forewing, ground colour white, strongly mottled due to brown tipped scales; basal part of costa densely covered by dark brown scales; cilia grey; cilia line indistinct. Hindwing brownish; cilia light creamy grey.

Male genitalia (fig. 1). — Uncus lobes small, with short setae. Gnathos more or less rounded when ventrally viewed. Tegumen widening basally. Valva short and broad, costa strongly sclerotized, narrow, convex, slightly setose, sacculus curved to angular, cucullus distinct but narrow, setose. Juxta U-shaped, lobes long, broad, distally with acute spine-like process; digitate process very small, slightly setose. Vinculum typical for the genus, weakly developed. Aedeagus strongly sclerotized, slightly tapering to distal end, two triangular lobes at base.

Biology. Unknown. Holotype caught in June.

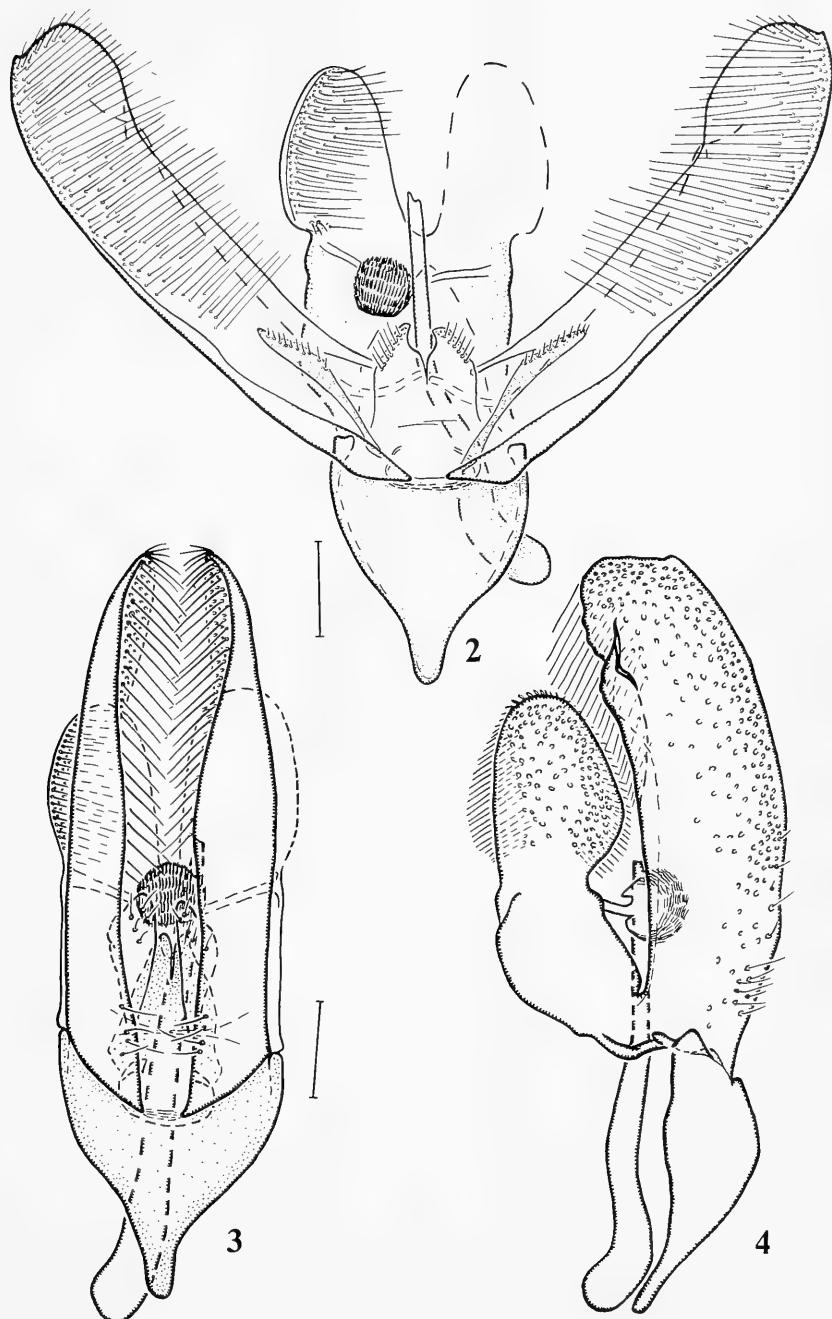
Distribution (fig. 25). — Only known from the holotype, Tadzhikistan.

Elachista fuscofrontella sp. n. (figs. 2-4, 26)

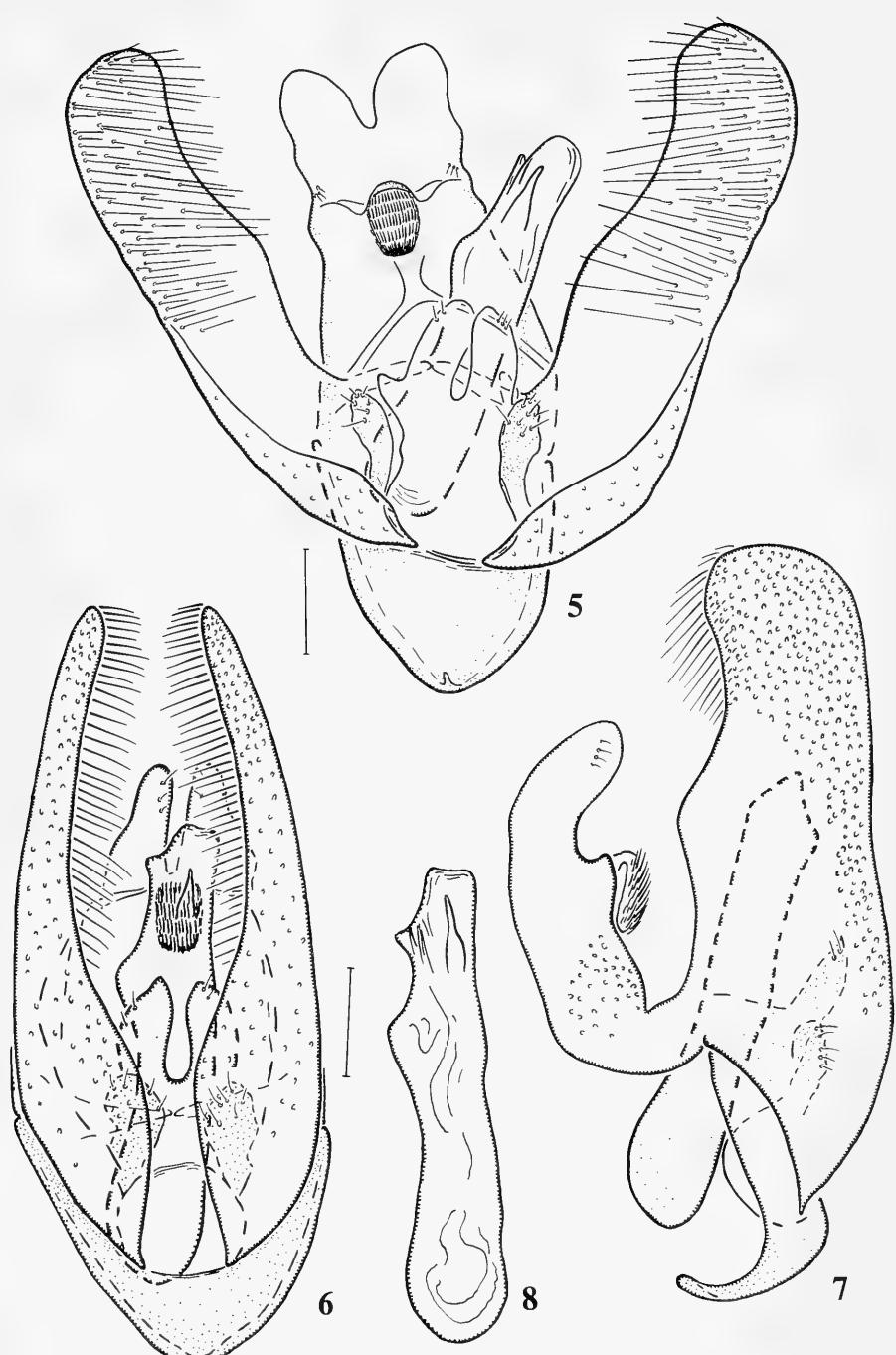
Type material. — Holotype ♂: USSR, Primorskiy Kray, 10 km S Slavyanka (Ryazanovka), 5.viii.1983, R. Puplesis (MG).

Diagnosis. — Closely related to *E. albifrontella* (Hübner). Differs in having a darker frons and labial palp, aedeagus curved in basal part without cornuti, saccus gradually tapering, digitate process club-shaped, widest above the middle, juxta lobes not dilate.

External characters. — Male (female unknown). Forewing length 3.0 mm. Frons, neck tuft greyish brown, silvery lustre. Antenna greyish and dark



Figs. 2-4. *Elachista fuscofrontella*, holotype. 2-3, male genitalia ventral view; 4, male genitalia lateral view. Scale 0.1 mm.



Figs. 5-8. *Elachista multipunctata*, holotype, male genitalia. 5-6, ventral view; 7, lateral view; 8, aedeagus. Scale 0.1 mm.

brown ringed, slightly serrate distally. Labial palp whitish from above, dark brown from below. Thorax and tegulae greyish brown, some silvery lustre. Forewing, ground colour dark grey, strongly mottled, scale tips almost black; medially interrupted, silvery, curved fascia before middle above fold; tornal and costal spots whitish, apical spot, shiny, silvery, not regular in shape; cilia brownish. Hindwing brown; cilia brownish.

Male genitalia (figs. 2-4). — Uncus deeply indented, lobes large, setose. Gnathos rounded; costa of valva strongly sclerotized, short prominent hump. Juxta, lobes not apically dilate; digitate process club-shaped, very wide above middle. Vinculum, not long, without medial ridge; saccus gradually narrowing. Aedeagus curved in basal part, gradually tapering, no cornuti.

Biology. — Unknown. Holotype caught in August.

Distribution (fig. 26). — Primorskiy Kray.

Elachista multipunctata sp. n. (figs. 5-8, 25)

Type material. — Holotype ♂: USSR, Tadzhikistan, 30 km N Dushanbe, env. Varzob (Kondara), 20.viii.1986, R. Puplesis (MG).

Diagnosis. — Very closely related to *E. maculata* Parenti. Differs in having the juxta lobes and digitate process widening and the aedeagus with a large cornutus. Easily distinguished from related *E. pollinariella* Zeller by shape of the uncus and juxta.

External characters. — Male (female unknown). Forewing length 3.4 mm. Frons, neck tufts white. Antenna whitish and creamy ringed, pecten white. Labial palp white from above, brownish from below. Thorax white; tegulae white, some brown scales. Forewings, ground colour white, mottled due to brown tipped scales, basal part of costa covered by dark brown scales; cilia white, distal part grey; cilia line more or less distinct by dark brown tipped scales. Hindwing brownish white; cilia greyish white.

Male genitalia (figs. 5-8). — Uncus deeply indented, lobes strongly curved towards valvae. Gnathos oval. Valva widest in the middle, costa with convex lobe in the middle. Juxta, lobes wide, apically tapering; digitate process short, wide, slightly setose. Vinculum short; saccus strongly curved. Aedeagus strongly sclerotized, stout, sclerotized humps past the middle and apical, one large cornutus.

Biology. — Unknown. Holotype caught in August.

Distribution (fig. 26). — Tadzhikistan.

Elachista megagnathos sp. n. (figs. 9-12, 26)

Type material. — Holotype ♂: USSR, Primorskiy Kray, 20 km E Ussuriysk (Gornotayeznoe), 6.vii.1982, R. Puplesis (MG).

sis (MG). Paratype: 1 ♂, same data, 7.vii.1982 (ZIAS).

Diagnosis. — Closely related to *E. gleichenella* (Fabricius), easily distinguished from this species by the very large gnathos, shape of the valva and the basal extensions of the aedeagus. Uncus in contrast to *E. gleichenella* deeply indented, digitate process narrower.

External characters. — Male (female unknown). Forewing length 2.6 mm (holotype), 2.9 mm (paratype). Head grey-brown, shining silvery. Antenna brownish to brown, distal half slightly serrate. Labial palp descending, whitish, shining from above, brownish from below. Thorax grey-brown, shining silvery. Forewing, ground colour blackish brown with bronze lustre, silvery marks with goldish lustre, basal spot reaching costa, medial fascia distinct, slightly widened in anal end, distal part of forewing with second, V-shaped fascia, cilia greyish brown. Hindwing brown; cilia greyish brown.

Male genitalia (figs. 9-12). — Uncus deeply indented, lobes with small setae. Gnathos prominent, very large. Valva widest in middle, costa convex, cucullus setose. Juxta, apical part of lobes narrowing, triangular; digitate process typical for majority of the genus, broad, short with fine setae. Vinculum not long, more or less triangular. Aedeagus strongly sclerotized, characteristically bent just below distal end, basally extended into two lateral arms.

Biology. — Unknown. Specimens were caught in July.

Distribution (fig. 26). — Primorskiy Kray.

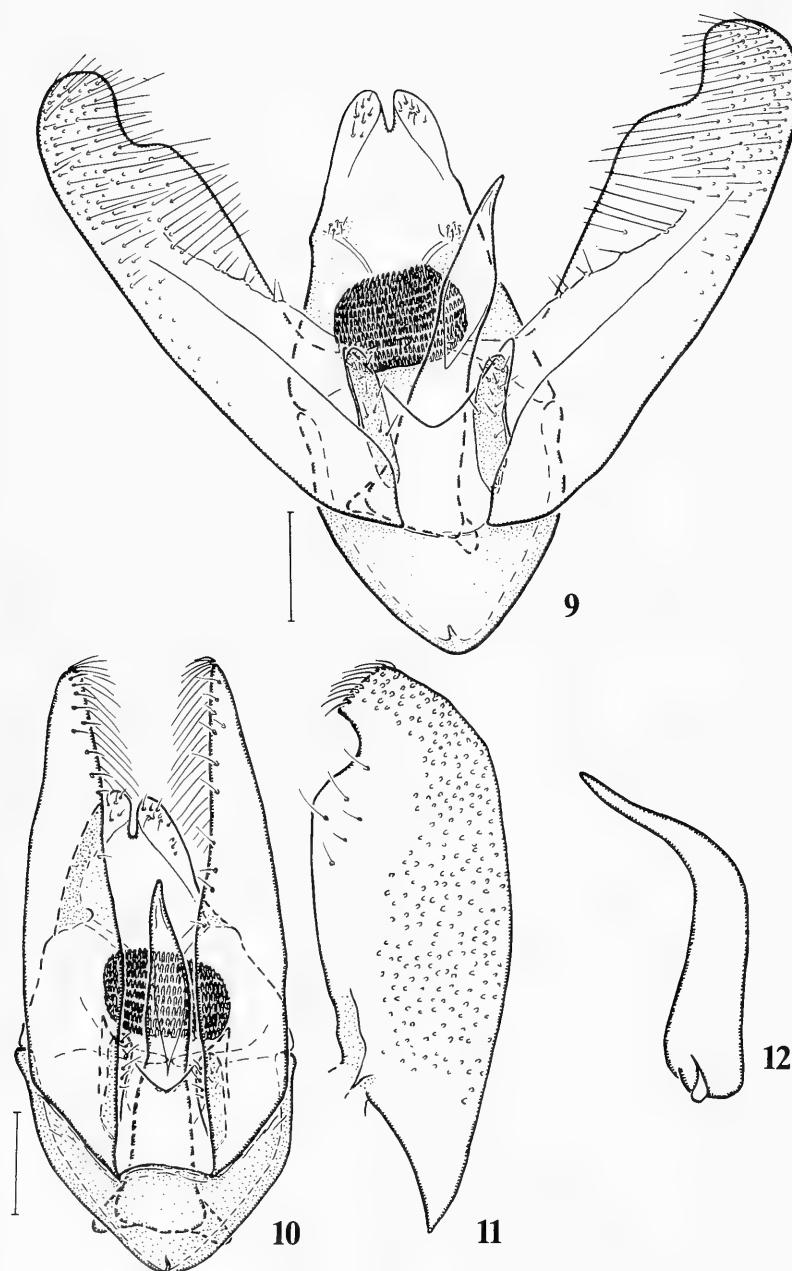
Biselachista spinigera sp. n. (figs. 13-16, 25)

Type material. — Holotype ♂: USSR, Turkmeniya, western Kopet Dag, 30 km E Kara-Kala (Juvan-Kala), 18.viii.1988, V. Sruoga (MG).

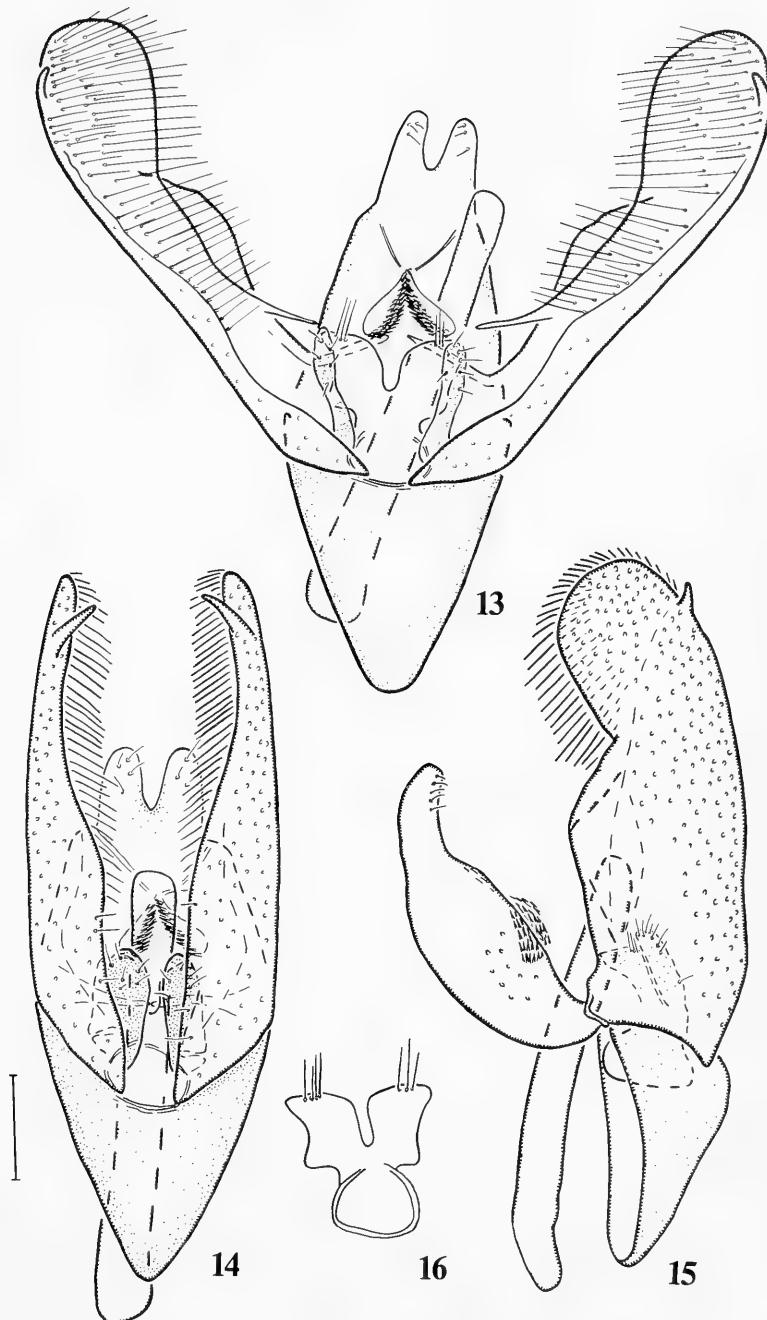
Diagnosis. — Closest related to *B. serricornis* (Stainton). Distinguished by the long and distinct distal spine of the sacculus and the shape of the valvae and gnathos.

External characters. — Male (female unknown). Forewing length 3.7 mm. Frons and neck tufts white. Antenna brownish-creamy, distal part of distal half slightly serrate, pecten white. Labial palp white, basal part brownish from below. Thorax white; tegulae white, some brownish scales. Forewing, ground colour white, three brown spots, one behind the middle, near costal margin, other two, irregular in shape, in tornal and apical position; cilia white; cilia line absent. Hindwing brownish; cilia brownish.

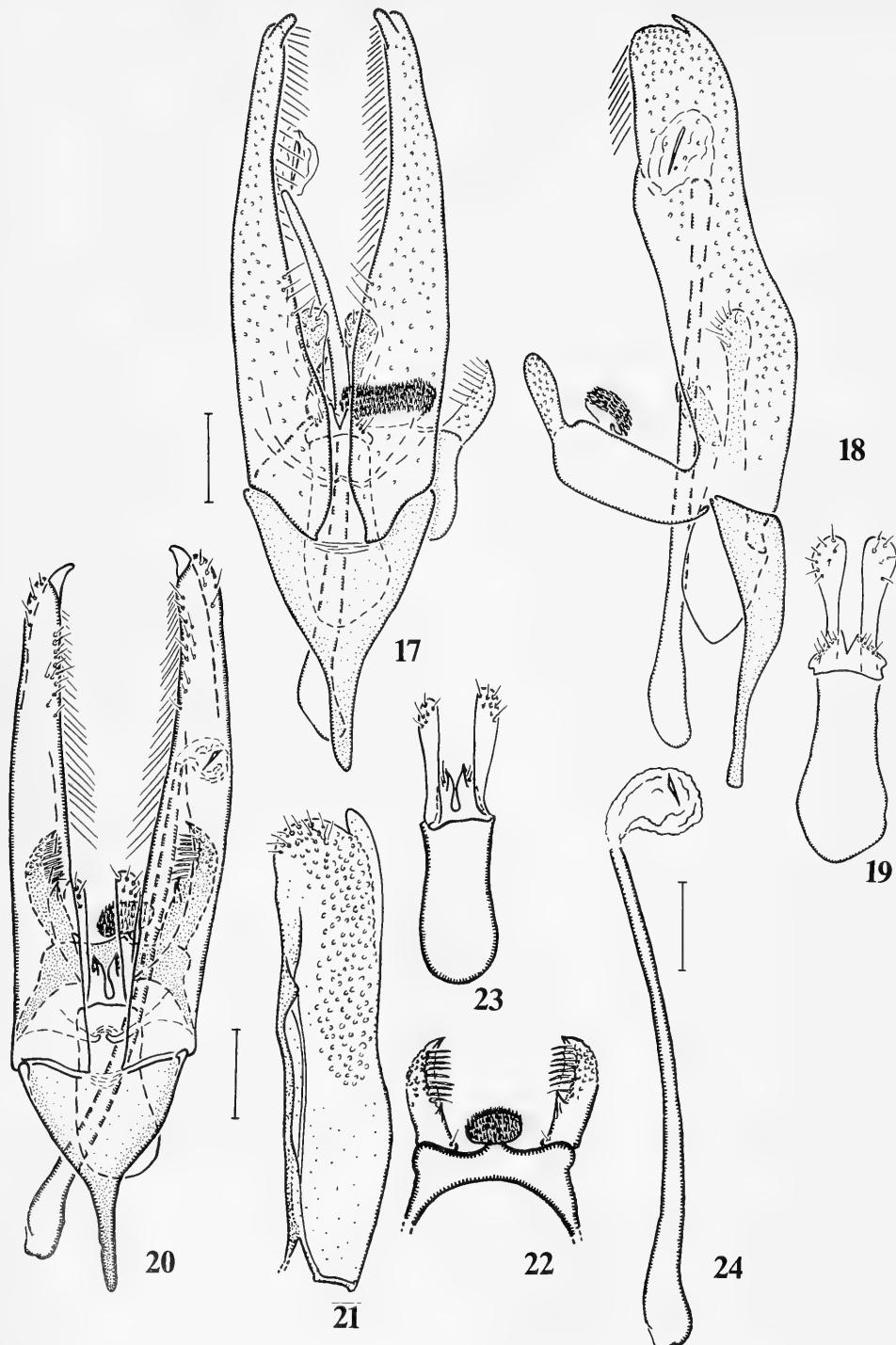
Male genitalia (figs. 13-16). — Uncus deeply indented, lobes slightly setose. Gnathos, lobes elongate. Tegumen basally widening. Valva, sacculus with long and distinct distal spine, costa strongly convex in the middle, cucullus widely rounded.



Figs. 9-12. *Elachista megagnathos*, holotype, male genitalia. 9-10, ventral view; 11, valva, lateral view; 12, aedeagus, lateral view. Scale 0.1 mm.



Figs. 13-16. *Biselachista spinigera*, holotype, male genitalia. 13-14, ventral view; 15, lateral view; 16, juxta. Scale 0.1 mm.



Figs. 17-24. Male genitalia. 17-19. *Cosmiotes kopetdagica*, holotype. 17, ventral view; 18, lateral view; 19, juxta, anellus and digitate process. 20-24. *Cosmiotes pallens*, holotype. 20, ventral view; 21, valva, lateral view; 22, uncus, gnathos and tegumen; 23, juxta, anellus and digitate process; 24, aedeagus. Scale 0.1 mm.



Fig. 25. Distribution map: *Perittia biloba* (dot), *Elachista multipunctata* (dot), *Biselachista spinigera* (triangle), *Cosmiotes kopetdagica* (rectangle), *Cosmiotes pallens* (rectangle).

Juxta, lobes broad, tapering dorso-lateral, small group of setae on apical margin; digitate process narrow at base, widest above the middle, setose. Vinculum triangular. Aedeagus more or less straight.

Biology. — Unknown. Holotype caught in August.

Distribution (fig. 25). — Turkmeniya.

Cosmiotes kopetdagica sp. n. (figs. 17-19, 25)

Type material. — Holotype ♂: USSR, Turkmeniya, western Kopet Dag, 40 km E Kara-Kala, 28.v.1988, V. Sruoga (MG).

Diagnosis. — Closely related to *C. amseli* Parenti. Distinguished from this species by the shape of the juxta lobes and the very large gnathos.

External characters. — Male (female unknown). Forewing length 3.6 mm. Frons and neck tufts greyish white, whitish lustre. Antenna whitish grey and brown ringed, distally slightly serrate. Labial palp white with some lustre from above, brownish from below. Thorax and tegulae brownish. Forewing, ground colour brownish grey, some silvery lustre, strongly mottled with brown scales, distal part mottled by dark brown scales, distinct white spots at tornus and costa, indistinct small whitish spots near costa and approximately in the middle of the forewing; cilia greyish; cilia line indistinct. Hindwing greyish brown; cilia grey.

Male genitalia (figs. 17-19). — Gnathos very large, oval, broadened. Valva, distal spine of sacculus large, distinct, acute. Juxta, lobes short, triangular in ventral view, small setae; digitate process long, distal part broad and setose. Vinculum triangular; saccus long, gradually tapering. Aedeagus long and slender, curved at base, long spine-like cornuti.

Biology. — Unknown. Holotype caught in May.

Distribution (fig. 25). — Turkmeniya.

Cosmiotes pallens sp. n. (figs. 20-24, 25)

Type material. — Holotype ♂: USSR, Turkmeniya, western Kopet Dag, 40 km E Kara-Kala, 28.v.1988, V. Sruoga (MG).

Diagnosis. — Most similar to *C. freyerella* (Hübner). Easily distinguished from this and other related species by more or less pale forewings, broad gnathos and broad distal spine of sacculus, large anellus and presence of cornuti in the aedeagus.

External characters. — Male (female unknown). Forewing length 2.5 mm. Frons and neck tuft whitish creamy. Antenna creamy brownish, distal part finely serrate, scape brown, pecten creamy. Labial palp creamy white. Thorax whitish to creamy white, some yellowish-brown scales; tegulae brown. Forewing, ground colour whitish to creamy white, some yellowish-brown scales, brown scales in two irregular spots in middle and abundantly present in apical part of forewing, basal part of forewing paler, dominated by whitish-creamy scales; cilia greyish-creamy, some scattered brown scales; cilia line indistinct. Hindwing of holotype lost.

Male genitalia (figs. 20-24). — Gnathos broad. Valva, distal spine of sacculus very distinct and broad, not acute. Juxta, lobes short with fine setae, apical margin sharp; digitate process long, distally broad, setose; anellus very large. Vinculum with long, narrow saccus. Aedeagus long, slender, with acute cornuti.

Biology. — Unknown. Holotype caught in May.

Distribution (fig. 25). — Turkmeniya.

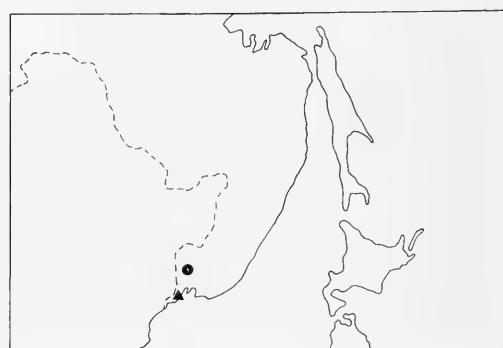


Fig. 26. Distribution map: *Elachista fuscofrontella* (triangle), *Elachista megagnathos* (dot).

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References

Brandt, F.H., 1942. Lepidopterologische Sammelerinnerungen aus dem gebiet der Ammat (Livland) mit einem Verzeichnis der dort gesammelten Arten. – Korrespondenzblatt des Naturforscher-Vereins zu Riga 64: 244.

Braun, A.F., 1948. Elachistidae of North America (Microlepidoptera). – Memoirs of the American Entomological Society 13: 1-110, 26 pls.

Ershov, N. & A. Fild, 1870. Katolog cesuekrylyh Rossijskoy imperii. – Trudy russkogo entomologiceskogo obshchestva 4: 118.

Falkovitsh, M.I., 1981. Semeistvo Elachistidae zlakovye moli-miniory (in Russian). – Opredelitel nasekomych Evropeiskoi casti SSSR 4(2): 479-523.

Falkovitsh, M.I., 1986. Cesuekrylye (Lepidoptera) ostan-covyh gor Kuldzuktau i podgornoj ravnini (jugo-zapadnij Kizilkum) (in Russian). In Fauna cesuekrylyh (Lepidoptera) SSSR. – Trudy vsesojuznogo entomologiceskogo obvestva 67: 131-186.

Falkovitsh, M.I. & A.A. Stekolnikov, 1978. Otriad Lepidoptera-Cesuekrylye. Vvedenie (in Russian). – Opredelitel nasekomych Evropeiskoi casti SSSR 4(1): 5-39.

Gorodkov, K.B., 1961. Prosteyshiy microproyector dlya risovaniya nasekomych (in Russian). – Entomologeskoe obozrenie 40: 936-939.

Ivinskis, P., Pakalniskis, S. & Puplesis, R., 1985. – Augalus minuojanys vabdziai: 107-112. Mokslas, Vilnius.

Kuroko, H., 1982. Elachistidae. – In Inoue, H., Sugi, S., Kuroko, H., Moriuti, S. & A. Kawabe. Moths of Japan 1: 259-260. Kadansha, Tokyo.

Kuusik, A., 1962. Märkmeid Eesti Pisiliblikatest. – Faunastilisi Märkmeid 1, 3. Loodu-Suurjate Selts Eesti NSV Teaduste Akadeemia Juures: 228-235.

Lienig, F., 1846. Lepidopterologische Fauna von Livland und Kurland. – Isis 3/4: 299.

Nielsen, E.S. & E. Traugott-Olsen, 1978a. Elachistidae (Lepidoptera) described by O. Staudinger, J. Mann and C. Mendes. – Entomologist's Gazette 29: 5-16.

Nielsen, E.S. & E. Traugott-Olsen, 1978b. A reassessment of the genus *Stephensia* Stainton, 1858 (Lepidoptera, Elachistidae). – Entomologist's Gazette 29(4): 183-200.

Nielsen, E.S. & E. Traugott-Olsen, 1981. A new species and a new combination in the genus *Stephensia* Stainton, 1885 (Lepidoptera: Elachistidae). – Entomologist's Gazette 32: 245-250.

Nielsen, E.S. & E. Traugott-Olsen, 1987. Four new west Palaearctic species of Elachistidae (Lepidoptera). – Entomologist's Gazette 38: 103-116.

Nolcken, J.H.W., 1871. Lepidopterologische Fauna von Estland, Livland und Kurland. – Arbeiten des Naturforscher-Vereins zu Riga 4: 1-392.

Palionis, A., 1932. Idėlis Lietuvos drugių faunai pažinti. – Vytauto Didžiojo Universiteto Matematikos-Gamtos fakulteto darbai 1931-1932 6: 181.

Parenti, U., 1978. Nuove specie paleartiche del genere *Elachista* Treitschke (Lepidoptera, Elachistidae). – Bollettino del Museo di Zoologia dell' Universita di Torino 4: 15-26.

Parenti, U., 1981. Nuove specie di Elachistidi paleartici (Lepidoptera: Elachistidae). – Bollettino del Museo di Zoologia dell' Universita di Torino 4: 49-64.

Parenti, U., 1983. Elachistidi del Giappone (Lepidoptera, Elachistidae). – Bollettino del Museo Regionale di Scienze Naturali Torino 1(1): 1-20.

Petersen, W., 1924. Lepidopteren-Fauna von Estland (Esti) 2: 511. – Reval, Talinn.

Prüffer, J., 1947. Studia nad motylami Wilenszczyzny. – Towarzystwo Naukowe w Toruniu. Wydział Matematyczno-Przyrodniczy: 278, 296.

Saar, H., 1930. Insektenbeobachtungen in Livland, II. – Korrespondenzblatt des Naturforscher-Vereins zu Riga 60: 102-104.

Savenkov, N., 1984. Nekotoriye danniye po faune i ekologiyi cesuekrylykh Latvii (in Russian). – Latvijas Entomologijas 27: 60.

Savenkov, N., 1987. Noviye danniye po faune i ekologiyi cesuekrylykh Latvii (in Russian). – Latvijas Entomologijas 30: 72.

Schille, F., 1931. Fauna motyli Polski. – Prace monograficzne Komisji fizjograficznej 2: 258-265.

Sinev, S.Ju., 1988. K faune cesuekrylykh (Lepidoptera) Pecengskogo rajona Murmanskoy oblasti (in Russian). – Svyazi entomofaun severnoj Evropy i Sibiri: 168-172.

Sukhareva, I.L. & M.I. Falkovitsh, 1984. Cesuekrylye (Lepidoptera) bolshogo Beriozovogo ostrova (in Russian). – Materialy po faune Vyborgskogo zakaznika 123: 73-115.

Šulcs, A. & I. Šulcs, 1983. Neue und wenig bekannte Arten der Lepidopteren-Fauna Letlands. 9. Mitteilung. – Notulae Entomologicae 63: 39.

Šulcs, A. & I. Šulcs, 1984. Neue und wenig bekannte Arten der Lepidopteren-Fauna Letlands. 10. Mitteilung. – Notulae Entomologicae 64: 153.

Šulcs, A. & I. Šulcs, 1987. Neue und wenig bekannte Arten der Lepidopteren-Fauna Letlands. 11. Mitteilung. – Notulae Entomologicae 67: 143.

Teich, K., 1889. Baltische Lepidopteren-Fauna. Microlepidoptera. – Arbeiten des Naturforscher-Vereins zu Riga N. F. 6: 125-126.

Teich, K., 1893. Nachtrag zur baltischen Lepidopteren-Fauna. – Arbeiten des Naturforscher-Vereins zu Riga N. F. 6: 1-33.

Teich, K., 1899. Vervollständigtes Verzeichnis der Schmetterlinge der Baltischen Provinzen. – Korrespondenzblatt des Naturforscher-Vereins zu Riga 42: 9-76.

Traugott-Olsen, E., 1985a. Five new *Elachista* species from Sierra Nevada. – SHILAP Revista de lepidopterologica 13(49): 73-76.

Traugott-Olsen, E., 1985b. Three new *Elachista* – species and supplement to the description of the five n. sp. from Sierra Nevada. – SHILAP Revista de lepidopterologica 13(49): 169-174.

Traugott-Olsen, E., 1988. The *Elachista* triseriatella Stainton complex, with descriptions of eight new species (Lepidoptera: Elachistidae). – Entomologist's Gazette 39: 293-311.

Traugott-Olsen, E. & E.S. Nielsen, 1977. The Elachistidae (Lepidoptera) of Fennoscandia and Denmark. – Fauna entomologica scandinavica 6: 1-299.

Whitebread, S.E., 1984. A new species of *Peritia* Stainton from Switzerland (Elachistidae). – Nota lepidopterologica 7: 271-281.

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ZUR ZOOGEOGRAPHIE DER WESTPALÄARKTISCHEN TIPULIDEN. IX. DIE TIPULIDEN DES VORDEREN ORIENTS.

Theowald, Br. & P. Oosterbroek, 1990. Zur Zoogeographie der Westpaläarktischen Tipuliden. IX. Die Tipuliden des Vorderen Orients. — Tijdschrift voor Entomologie 133: 85-95, figs. 1-3, tabs. 1-4 + 1 appendix [ISSN 0040-7496] Published 31 July 1990.

A review is presented of the 198 species and subspecies of Tipulidae known from the Near East. The Tipulidae fauna of the Near East distinctly belongs to the Westpalaearctic but has an isolated position as is clear from the high amount of endemic species (67%).

The Near East can be divided in two regions of different faunal composition, the Southeast with predominantly Mediterranean, and the Northwest with a majority of European and Eurasian (sub)species.

About 50% of the (sub)species belongs to the subgenus *Lunatipula*. It is concluded that the differentiation within the larger species-groups of *Lunatipula* dates back to at least the Lower Miocene.

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Key words. — Diptera; Tipulidae; Near East; Zoogeography.

EINLEITUNG

In dieser Arbeit sind die Tipuliden des Vorderen Orients zusammengefaßt. Zum Vorderen Orient sind hier gezählt: die asiatische Türkei (Anatolien), die Sovjet Republiken südlich des Kaukasus (Transkaukasien: Georgien, Azerbaidjan, Armenien), Iran, Irak, Syrien, Libanon, Jordanien, Israel und Nordägypten (Fig. 1). Untersuchungen der Tipulidenfauna dieser Gebiete haben erst spät angefangen. Bis 1960 waren insgesamt etwa 50 Arten und Unterarten bekannt, heute sind es 198. Damit ist aber die Tipulidenfauna des Vorderen Orients sicher nicht vollständig bekannt. Manche neue Ausbeute enthält wieder von dort unbekannte Arten und von schon bekannten Arten neue Fundorte.

Für diese Arbeit wurden Daten aus der Literatur und aus der Sammlung des Zoologischen Museums, Amsterdam, zusammengetragen. Der Großteil der dort befindlichen Tipuliden des Vorderen Orients wurde gesammelt von A. & U. Aspöck, H. v. d. Brink, J. Lucas, H., T. & B. v. Oorschot, H. & R. Rausch, F. Ressl und H. Wiering. Wir sind ihnen und allen anderen Sammlern für das Material, das sie uns überließen, sehr dankbar.

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Für "Arten und Unterarten" ist im Text der Kürze wegen die Bezeichnung "Arten" verwendet.

VEGETATION DES VORDEREN ORIENTS

Ursprünglich war der Vordere Orient (Rikli 1946; Atlas of the Arab World and the Middle East 1960) größtenteils trockene Grassteppe und Wüste, Biotope, die kaum für Tipuliden geeignet sind. Es gab aber auch Wald und Wiesen: hauptsächlich entlang der Küsten, in den Gebirgen von Transkaukasien, Iran und Ostanatolien und entlang der größeren Flüsse (z.B. Nil, Euphrat, Tigris) (Fig. 2). In den höheren Lagen der Gebirge gab es große Flächen von sommergrünem Laubwald und Mischwald, in den niederen Lagen mehr immergrünen mediterranen Wald.

Der Vordere Orient ist eines der ältesten Kulturgebiete der Erde. Vor etwa 6000 Jahren wurde dort bereits mit Landwirtschaft angefangen, und diese hat sich seither über den größten Teil des Gebietes ausgebreitet. Vor 3500 Jahren gab es schon viele Städte. Eine so lange Zeit von Landwirtschaft und andere Beeinflussung der Vegetation durch menschliche Aktivitäten, wie zum Beispiel Holznutzung für Bau und Brennstoff, hatte einen starken Einfluß auf Flora und Fauna. Zuerst wurden die feuchten Gebiete entlang der Flüsse für Landwirt-

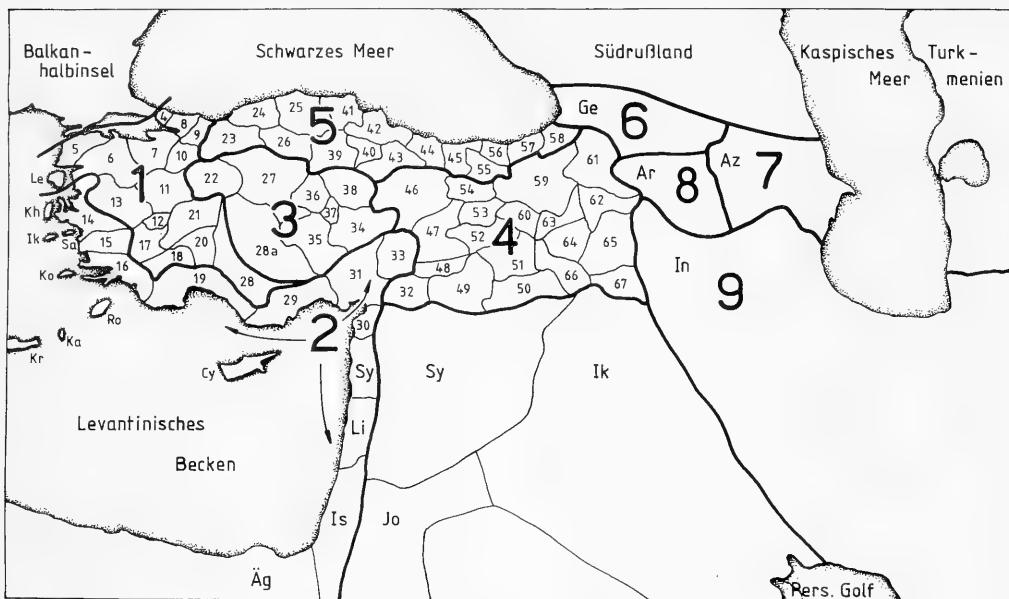


Fig. 1. Der Vordere Orient mit Hauptgebieten, Staten, türkischen Provinzen und Inseln. Von türkischen Provinzen markiert # sind keine Tipuliden bekannt.

Hauptgebiet 1: Westanatolien

Le	Lesbos	7	Bursa	11	Kütahya	18	Burdur
4 #	Istanbul	8	Kocaeli	12 #	Usak	20	Isparta
5	Canakkale	9	Sakarya	13 #	Manisa	21	Afyon
6 #	Balikesir	10	Bilecik	17	Denizli	28	Konya p. p.

Hauptgebiet 2: Levantinisches Küstengebiet

Kh	Khios	Cy	Cyprus	29	Icel	Li	Libanon
Ik	Ikaria	14	Izmir	30	Hatay	Is	Israel
Sa	Samos	15	Aydin	31	Adana	Ag	Ägypten
Ko	Kos	16	Mugla	33	Maras		
Ro	Rodhos	19	Antalya	Sy	Syrien		

Hauptgebiet 3: Zentralanatolien

22 #	Eskisehir	28a	Konya p. p.	35	Nigde	37	Nevsehir
27	Ankara	34	Kayseri	36 #	Kirsehir	38 #	Yozgat

Hauptgebiet 4: Ostanatolien

32 #	Gaziantep	50	Mardin	59	Erzurum	64	Bitlis
46	Sivas	51 #	Diyarbakir	60	Bingöl	65	Van
47 #	Malatya	52 #	Elazig	61	Kars	66	Sürt
48	Adiyaman	53 #	Tunceli	62	Agri	67	Hakkari
49	Urfra	54 #	Erzincan	63	Mus		

Hauptgebiet 5: Nordanatolien

23	Bolu	39 #	Corum	43	Tokat	56	Trabzon
24	Zonguldak	40	Amasya	44	Ordu	57	Rize
25	Kastamonu	41	Sinop	45	Giresun	58	Artvin
26 #	Cankiri	42 #	Samsun	55	Gümüsane		

Hauptgebiet 6: Georgien

Hauptgebiet 7: Azerbaidjan

Hauptgebiet 8: Armenien

Hauptgebiet 9: Iran

schaft genutzt, und die ursprüngliche Vegetation und Fauna ist dort fast restlos verschwunden. In den feuchteren Gebieten der Gebirge wurden Laub- und Mischwälder großtenteils abgeholt, und der Boden wurde über kürzere oder längere Zeit landwirtschaftlich genutzt. Im ganzen Gebiet sind heute nur noch voneinander isolierte Laub- und Mischwaldreste übrig, besonders in den weniger zugänglichen Teilen der Gebirge. Viele der in älteren Zeiten für Landwirtschaft genutzten Gebiete sind heute entweder mit trockener mediterraner Hartlaubvegetation bewachsen, oder zu Steppen und Wüsten geworden.

Die Vegetation des Vorderen Orients schließt im Nordwesten und Norden nahe an jene der Balkanhalbinsel und Südrusslands an. Von der Balkanhalbinsel ist sie getrennt durch Bosporus und Dardanellen, die aber stellenweise weniger als 5 km breit sind. Von Südrussland ist sie getrennt durch das Schwarze Meer und den Kaukasus. Dieses Gebirge ist bis über 5000 m hoch, fällt aber an den Küsten des Schwarzen Meeres und des Kaspiischen Meeres bis ins Flachland ab. Im Nordosten ist der Vordere Orient vom sibirischen Gebiet getrennt durch das Kaspiische Meer und die Steppen und Wüsten von Turkmenien. Die Gebirge von Nordostiran gehen aber allmählich in die von Afghanistan und Zentralasien über. Für die mehr oder weniger feuchtigkeitsliebenden Tipuliden ist somit im Norden des Vorderen Orients Austausch mit der Balkanhalbin-

sel, mit Südrussland und mit Zentralasien wohl schwierig, jedoch nicht auszuschließen. Im Süden ist der Vordere Orient für die feuchtigkeitsliebenden Tipuliden aber vollständig abgeschlossen vom orientalischen und vom afrotropischen Gebiet durch die Steppen und Wüsten von Südafghanistan, Südiran, Irak, Syrien, Jordanien und Arabien. Fau-nenaustausch mit diesen Regionen ist also nicht zu erwarten.

ARTENLISTE (APPENDIX 1)

In der Artenliste sind die 198 Tipuliden des Vorderen Orients alphabetisch angeführt mit ihrer Verbreitung innerhalb und außerhalb des Gebietes. Aufgrund von Klima und Vegetation wurde der Vordere Orient in 9 Gebiete aufgeteilt, wobei aus praktischen Gründen soweit möglich die Grenzen von Staaten und Provinzen benutzt worden sind (Fig. 1). Die 9 Hauptgebiete sind: 1 Westanatolien, 2 das levantinische Küstengebiet, 3 Zentralanatolien, 4 Ostanatolien, 5 Nordanatolien, 6 Georgien, 7 Azerbaidjan, 8 Armenien, 9 Iran. Im Text zu Figur 1 sind die 9 Gebiete mit zugehörigen Staaten, türkischen Provinzen und Inseln verzeichnet. Die große türkische Provinz Konya ist aufgeteilt in den feuchteren gebirgigen Westen und Süden (28) und die mehr trockene Hochebene (28a). Die Inseln wurden zum nächstgelegenen Festland gerechnet. Nicht mitgezählt wurden Jordanien und Irak, von

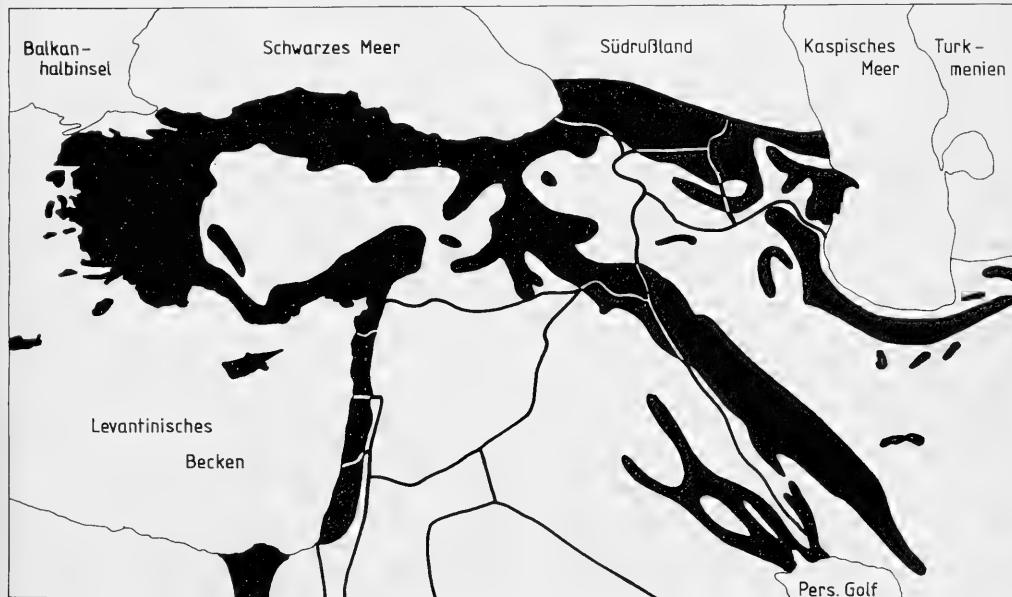


Fig. 2. Die ursprüngliche Vegetation des Vorderen Orients, schwarz: feuchte Gebiete mit Wald und Wiesen, weiß: trockene Gebiete mit Steppen und Wüsten.

welchen Staaten keine Tipuliden bekannt sind. Von Syrien sind Tipuliden nur bekannt vom Küstengebiet, von Iran fast nur von den Gebirgen südlich des Kaspischen Meeres. Von Ägypten ist nur eine Art bekannt, der Kulturschädling *T. (Tipula) orientalis*.

In der Artenliste ist die Verbreitung über die 9 Hauptgebiete verzeichnet, und in Klammern, in welcher der türkischen Provinzen oder auf welchen Inseln. Ebenso sind die Verbreitungstypen im paläarktischen Raum aufgenommen. Es bedeutet:

- A Hauptverbreitung in Asien;
- E Hauptverbreitung in Europa;
- EA Hauptverbreitung in Eurasien;
- M Nur verbreitet im mediterranen Raum der Westpaläarktis.

Die Endemiten sind mit e bezeichnet und dahinter steht jeweils einer der obengenannten Buchstaben. Die großgeschriebenen Buchstaben weisen auf die Verwandtschaft hin. So bedeutet zum Beispiel eA: die Art ist endemisch im Vorderen Orient, und ihre nächsten Verwandten haben asiatische Verbreitung.

ZOOGEOGRAPHISCHE BEMERKUNGEN

Stellung des Vorderen Orients im paläarktischen Raum

In Tabelle 1 sind die Tipuliden des Vorderen Orients zusammengefaßt und geordnet nach ihrem Vorkommen in den 9 Hauptgebieten und nach ihrer Verbreitung im paläarktischen Raum.

Der Vordere Orient beherbergt 8 Arten mit asiatischer Verbreitung oder Verwandtschaft (A und eA), 45 mit europäischer (E und eE) und 17 mit eurasischer (EA und eEA) Verbreitung oder Verwandtschaft. Die eurasischen Arten gehören zur westpaläarktischen Fauna, haben die Kaltzeiten am Ende des Pleistozäns im Balkan Refugium verbracht und sich seither über Europa und über kleinere oder größere Teile Asiens ausgebreitet (Theowald & Oosterbroek 1983, 1985).

Tabelle 1. Die Tipuliden des Vorderen Orients nach ihrem Vorkommen in den 9 Hauptgebieten.

Hauptgebiete	1	2	3	4	5	6	7	8	9	Total
<i>Verbreitungstyp</i>										
A	0	1	0	1	1	2	4	2	2	5
eA	1	1	0	1	0	0	1	0	0	3
E	7	10	5	7	9	16	9	12	4	28
eE	4	4	0	4	2	8	1	2	3	17
EA	4	2	3	6	6	10	7	5	5	12
eEA	1	0	1	1	1	4	2	1	3	5
M	12	10	2	3	4	6	3	4	3	21
eM	26	53	4	12	8	19	13	4	8	107
Total	55	81	15	35	31	65	40	30	28	198

Insgesamt 128 Arten gehören zur mediterranen Fauna der Westpaläarktis (M und eM). Mit 190 zur westpaläarktischen Fauna gehörigen Arten, gegenüber nur 8 ostpaläarktischen, gehört der Vordere Orient deutlich zur Westpaläarktis, ganz im Gegensatz zum borealen Europa, wo 64% der Tipuliden Arten von ostpaläarktischer Herkunft sind (Theowald & Oosterbroek 1985).

Innerhalb der Westpaläarktis hat der Vordere Orient jedoch eine isolierte Lage, was sich im hohen Anteil der Endemiten (67%) und im hohen Anteil der mediterranen Arten (64%) zeigt. In jedem einzelnen der südlichen Gebiete Europas (Balkanhalbinsel, italienisches Festland, iberisches Festland) gibt es weniger als 40% Endemiten und weniger als 35% mediterrane Arten.

Faunenzusammensetzung der 9 Hauptgebiete

Es gibt große Unterschiede in der Zahl der Arten, die von jedem einzelnen der 9 Hauptgebiete bekannt sind (Tabelle 1).

Zentralanatolien (Hauptgebiet 3) zählt nur 15 Arten. Dieses Gebiet ist eine trockene Hochebene mit Steppen und Wüsten, zum Teil bewässert und landwirtschaftlich genutzt. Was Tipuliden betrifft, ist es wahrscheinlich der ärmste Teil Anatoliens.

Von Iran (Hauptgebiet 9) kennen wir 28 Arten. Von diesem Land sind aber relativ wenige Ausbeuten bekannt, und wahrscheinlich kommen dort mehr Arten vor und sind besonders noch ostpaläarktische Arten zu erwarten.

Es gibt keine deutlichen Hinweise, daß in einigen der weiteren Gebiete auffallend mehr, in anderen auffallend weniger gesammelt worden ist, obwohl Unterschiede in der Zahl der bekannten Arten deutlich sind. Wahrscheinlich hängen diese Unterschiede mit dem Aufbau der Landschaft zusammen.

Tabelle 2 gibt die prozentuelle Faunenzusammensetzung der Hauptgebiete. In dieser Tabelle sind die europäischen und eurasischen Tipuliden zusammengestellt. Aufgrund der Faunenzusammensetzung läßt sich der Vordere Orient in ein südwestliches Gebiet (Hauptgebiete 1 und 2) und ein nordöstliches (Hauptgebiete 4 bis 9) aufteilen. Im südwestlichen Gebiet gibt es vorwiegend mediterrane Arten. Obwohl die europäischen und eurasischen Arten nur 31% der Gesamtfauna darstellen, sind sie im Nordosten in der Mehrheit. Prozentuell sind die Unterschiede mehr als deutlich: im Südwesten 69-78% mediterrane und weniger als 30% europäische Arten, im Nordosten 48-67% europäische und weniger als 27-43% mediterrane Arten. Hauptgebiet 3, mit nur 15 Arten schließt sich mit 60% europäischer Arten dem Nordosten an.

In Tabelle 3 sind die Tipuliden des Vorderen Orients eingeteilt in Arten mit südwestlicher Verbreitung, Arten mit nordöstlicher Verbreitung und Arten, die im Südwesten und im Nordosten vor-

Tabelle 2. Prozentuelle Faunenzusammensetzung der Tipuliden des Vorderen Orients in den 9 Hauptgebieten.

Hauptgebiete	1	2	3	4	5	6	7	8	9	Total
asiatische Arten	2	2	0	6	3	3	13	7	7	4
europeische und eurasische Arten	29	20	60	51	58	58	48	67	54	31
mediterrane Arten	69	78	40	43	39	38	40	27	39	65

kommen. Zu Arten mit südwestlicher Verbreitung werden jene gezählt, die wenigstens in Westanatolien und/oder dem levantinischen Küstengebiet vorkommen. Einige von diesen reichen mehr oder weniger weit in den Westen von Nordanatolien oder in den Südwesten von Ostanatolien, sie fehlen aber in Transkaukasien und Iran. Zu Arten mit nordöstlicher Verbreitung sind jene gezählt, die in Transkaukasien und Iran vorkommen. Zum Teil kommen sie auch im Osten von Nordanatolien und in größeren Teilen Ostanatoliens vor. Sie fehlen aber in Westanatolien und im levantinischen Küstengebiet.

Es gibt im Vorderen Orient von 198 Arten nur 19, die weitverbreitet sind. Sie sind ziemlich gleichmäßig über das ganze Gebiet verbreitet. Es fällt aber auf, daß 11 der 15 Arten von Zentralanatolien zu dieser Gruppe gehören. In den anderen Gebieten sind sie deutlich in der Minderheit. Unter ihnen sind mehrere bedeutende Kulturschädlinge.

Die übrigen 179 Arten sind ziemlich gleichmäßig auf Südwesten (93) und Nordosten (86) verteilt. Zwischen beiden Gebieten gibt es also nicht nur einen Unterschied im prozentuellen Anteil von europäischen und mediterranen Arten (Tabelle 2), jedes der beiden Gebiete zählt überdies mehr als 80% charakteristische Arten, die im anderen Gebiet nicht vorkommen. Die beiden Gebiete haben weniger als 20% ihrer Arten gemeinsam. Der Vordere Orient läßt sich somit in zwei deutlich voneinander verschiedene Faunengebiete einteilen: Südwesten und Nordosten. Ursache dafür ist wohl die Tatsache, daß beide Gebiete schon längere Zeit durch die Steppen und Wüsten von Zentralanatolien voneinander isoliert sind. Austausch von Arten war nur möglich entlang der Küste des Schwarzen Meeres über Nordanatolien und vielleicht auch noch zwischen dem levantinischen Küstengebiet und Ostanatolien im Süden der asiatischen Türkei.

Die europäischen und eurasischen Arten im Vorderen Orient

Die Mehrzahl der Arten mit europäischer oder eurasischer Verbreitung (E, EA) haben die Kaltzeiten am Ende des Pleistozäns in einer Reihe von Kleinrefugien auf der Balkanhalbinsel verbracht

und sich seither über Europa oder Eurasien ausgebretet (Theowald & Oosterbroek 1983, 1985). Von den insgesamt 40 nichtendemischen europäischen Arten im Vorderen Orient zeigen 31 eine ziemlich geschlossene Verbreitung von der Balkanhalbinsel über die Ukraine und Südrußland bis nach Georgien und/oder Azerbaidschan, und von dort reichen sie zum Teil weiter bis nach Iran oder in den Osten von Nord- und Ostanatolien, 7 reichen sogar bis nach Westanatolien und 4 bis in das levantinische Küstengebiet. Nur 4 der 40 nichtendemischen europäischen Arten sind von den Gebieten nördlich des Schwarzen Meeres und vom östlichen Faunengebiet des Vorderen Orients unbekannt. Sie sind nur bekannt vom Westen des Vorderen Orients. Die Verbreitung von 5 Arten ist unklar.

Ähnliches finden wir unter den 22 Endemiten mit europäischer oder eurasischer Verwandtschaft (eE, eEA). Die meisten haben eine nächstverwandte Art in den Gebieten nördlich des Schwarzen Meeres und auf der Balkanhalbinsel. Insgesamt 16 dieser Endemiten sind im östlichen Faunengebiet verbreitet, 2 davon bis Westanatolien. Rein westliche Verbreitung haben nur 6 Arten.

Die meisten europäischen und eurasischen Arten (47 aus 62) zeigen also mehr oder weniger deutlich eine Verbreitung von der Balkanhalbinsel über die Gebiete nördlich des Schwarzen Meeres bis in das östliche Faunengebiet des Vorderen Orients. Nur 15 Arten sind entweder nur vom westlichen Faunengebiet bekannt oder Verbreitung und/oder Verwandtschaft sind unklar. Die Gebiete nördlich des Schwarzen Meeres waren jedenfalls im Saalien (Riß) trockene Kältesteppen, und wenig weiter im Norden befand sich die Eisdecke des Ural. Der Osten des Vorderen Orients war damals also deutlich von der Balkanhalbinsel isoliert. Es ist deshalb anzunehmen, daß die europäischen Tipuliden sich erst rezent, am Ende des Pleistozäns oder im Holozän, von der Balkanhalbinsel über die Ukraine und Südrußland bis nach dem Osten des Vorderen Orients ausgebreitet haben. Ausbreitung vom Süden der Balkanhalbinsel über Bosporus und Dardanellen bis nach Westanatolien hat anscheinend bedeutend weniger stattgefunden.

Die mediterranen Arten im Vorderen Orient

Von den mediterranen Arten des Vorderen

Tabelle 3. Verteilung der südwest-, nordost- und weitverbreiteten Arten über die 9 Hauptgebiete.

Hauptgebiete	1	2	3	4	5	6	7	8	9	Total
Verbreitung										
südwest	39	71	4	9	4	0	0	0	0	93
nordost	0	0	0	13	16	52	28	16	20	86
weitverbreitet	16	10	11	13	11	13	12	14	8	19
Total	55	81	15	35	31	65	40	30	28	198

Tabelle 4. Artengruppen von *Lunatipula* nach den in Figur 3 erwähnten Gruppen und der Zahl der endemischen Arten und Unterarten im mediterranen Gebiete (West Mediterr. inkl. Makronesien und Nordwest Afrika; Italien inkl. Korsika, Sardinien und Sizilien; Balkan südlich Österreich und Ungarn; Vorderer Orient wie für diese Arbeit umschrieben). Die Gesamtzahl der paläarktischen *Lunatipula* Arten und Unterarten ist 340.

Mediterrane Gebiete	West Mediterr.	Italien	Balkan	Vordere Orient	Paläarktische Arten
Falcatae					
<i>falcata</i> -Gruppe	9	3			14
<i>helvola</i> -Gruppe	1	3			5
<i>bullata</i> -Gruppe		4			5
	10	10	—	—	
Fasciculatae A					
<i>livida</i> -Gruppe	11	4	10	17	74
	11	4	10	17 (= 40%)	
Fasciculatae B					
<i>verrucosa</i> -Gruppe				5	6
<i>caudispina</i> -Gruppe		3	8		11
<i>fascingulata</i> -Gruppe	3	2	8	1	19
	3	5	16	6 (= 20%)	
Spinosae A					
<i>fuscipennis</i> -Gruppe		2	1		8
<i>fulminis</i> -Gruppe			1		3
<i>truncata</i> -Gruppe			18		22
	—	2	20		
Spinosae B1					
<i>caucasica</i> -Gruppe		1	1	5	7
<i>macroselene</i> -Gruppe	1	1	4	19	30
<i>peliosigma</i> -Gruppe		2	2	12	19
	1	4	7	35 (= 74%)	
Spinosae B2					
<i>pustulata</i> -Gruppe	5				7
<i>clio</i> -Gruppe			5	1	6
<i>phaidra</i> -Gruppe			4	1	6
<i>acuminata</i> -Gruppe	3		13	33	53
<i>lunata</i> -Gruppe	1			8	14
	9	—	22	43 (= 58%)	

Orients sind 21 (M) unverändert auch von Gebieten außerhalb des Vorderen Orients bekannt und sind weiter 107 Endemiten (eM). Von den 21 Nichtenendemien sind 11 verbreitet vom Westen des Vorderen Orients bis auf die Balkanhalbinsel (einige sogar bis in das westmediterrane Gebiet), gegenüber nur 4, die vom Osten des Vorderen Orients bis nach Südrussland oder weiter verbreitet sind. Das bedeutet, daß es mehr Austausch von mediterranen Arten gegeben hat im Westen als im Osten. Eine Art (*T. (L.) cressa*) kommt auf Rodhos und Kreta vor. Sie gehört in die *phaidra*-Gruppe mit kretischer Verbreitung (siehe unten). Von 5 weiteren Arten ist die Verbreitung unklar. Sie sind entweder über das ganze ostmediterrane Gebiet, auch nördlich des Schwarzen Meeres, verbreitet, oder sie zeigen in ihrer Verbreitung große Disjunktionen.

Von den 107 Endemiten haben 60 eine südwestliche, und 39 eine nordöstliche Verbreitung. Ob-

wohl die Arten also größtenteils rein südwestlich oder nordöstlich sind, gibt es unter den Artengruppen, zu welchen sie gehören, kaum Hinweise auf eine derartige geografische Zweiteilung. Die größeren Artengruppen (*livida*-, *macroselene*-, *peliosigma*-, *acuminata*- und *lunata*-Gruppe) haben etwa gleichviele Arten im Westen und im Osten des Vorderen Orients. Wahrscheinlich waren diese Gruppen schon über den Vorderen Orient verbreitet, bevor dieses Gebiet durch Austrocknung des zentralanatolischen Gebietes in zwei Faunengebiete geteilt wurde.

Die Untergattung *Tipula* (*Lunatipula*) im Vorderen Orient

Im Vorderen Orient gehören 124 der 198 Tipuliden (63%) zur Untergattung *Lunatipula*. Die paläarktischen Arten dieser Untergattung wurden, hauptsächlich durch Mannheims (1963-1968) und

Savtshenko (1964), eingeteilt in 27 Artengruppen, von denen 19 auch im Vorderen Orient heimisch sind. Die Verwandtschaftsbeziehungen zwischen den Artengruppen wurden durch die beiden Autoren aber nicht klargestellt.

Eine Einteilung der paläarktischen *Lunatipula*-Arten in einige größere Hauptgruppen wurde schon von Riedel (1913) versucht, der ohne weitere Begründung die Untergattung aufteilt in *Falcatae*, *Fasciculatae* und *Spinosae*. Es ist möglich diese Einteilung teilweise durch Synapomorphien zu belegen, mit einer weiteren Aufspaltung der *Fasciculatae* und *Spinosae* (Fig. 3).

1. Adminiculum mit deutlichen membranösen Strukturen seitlich des Penisführers, die ihn größtenteils oder ganz verdecken. Plesiomorph sind derartige Strukturen nicht anwesend und liegt der Penisführer unbedeckt.

2. Seitlich des Penisführers finden sich neben der differenzierte größere oder kleinere blattförmige Strukturen überdies kleinere oder größere Dornen.

3. Seitlich des Penisführers finden sich stark sklerosierte Dornen und nur Reste von membranösen blattförmigen Strukturen.

4. Am Hinterrand des 8. Sternits der Männchen sind zwei Anhänge die meist kurze Dornen tragen.

5. Die Anhänge des 8. Sternits tragen einen langen geschwungenen Dorn.

6. Zwischen den Anhängen des 8. Sternits befindet sich ein Haarplättchen.

Tabelle 4 gibt die Einteilung der 19 Artengruppen des Vorderen Orients unter den 6 Hauptgruppen von Figur 3, und die Zahl ihrer mediterranen Endemiten. Drei Arten der Balkanhalbinsel, die Mannheims in die *falcata*-Gruppe stellt, werden hier, conform mit Savtshenko, zu der *fasciculata*-Gruppe gezählt, wohin sie aufgrund des Baues des Adminiculum gehören.

Aus Tabelle 4 geht hervor, daß den hochdifferenzierten *Spinosae* B1 und B2 im Vorderen Orient die größte Bedeutung zukommt. Von den zugehörigen 121 mediterranen Endemiten dieser Gruppen haben 78 (64%) dort ihre Verbreitung. Es ist anzunehmen, daß die *Spinosae* B1 und B2 sich im Vorderen Orient differenziert haben, und daß sich später Arten von dort weiter ausgebreitet haben.

Von den übrigen Hauptgruppen haben *Fasciculatae* B und *Spinosae* A vorwiegend balkanische Verbreitung, sind die *Fasciculatae* A ziemlich gleichmäßig über die ganze Paläarktis verbreitet (besonders die *livila*-Gruppe) und findet sich die älteste Gruppe der *Falcatae* nur im westmediterranen Gebiet.

Die Differenzierung der Hauptgruppen im ostmediterranen Gebiet hat wahrscheinlich schon im Unteren Miozän oder früher angefangen. Eine sogenannte kretische Verbreitung über die südaegäischen Inseln zeigt sich in der *bimacula*-Subgruppe (*livila*-Gruppe, *Fasciculatae* A), der *verrucosa*-Gruppe (*Fasciculatae* B), der *cretis*-Subgruppe (*macrostene*-Gruppe, *Spinosae* B1) und der *phaidra*-Gruppe (*Spinosae* B2) (Theowald & Oosterbroek 1990). Eine derartige Verbreitung geht wahrscheinlich zurück auf eine Zeit, in der es von Südgriechenland über Kreta und Rhodos bis nach Westanatolien eine Landbrücke gab. Diese Landbrücke ist in der zweiten Hälfte des Miozäns zu Inseln auseinander gefallen (Parent 1988). Dies bedeutet, daß die meisten Hauptgruppen von *Lunatipula*, auch die hochdifferenzierten *Spinosae* B1 und B2, schon damals existierten.

ZUSAMMENFASSUNG

Unter den insgesamt 198 Tipuliden Arten im Vorderen Orient sind 8 ostpaläarktischen gegenüber 190 westpaläarktischen. Der Vordere Orient gehört somit klar zur Westpaläarktis. Charakteristisch für das Gebiet ist die große Zahl von Endemiten und mediterranen Arten.

Der Vordere Orient läßt sich in zwei Faunengebiete aufteilen: ein südwestliches und ein nordöstliches. Beide haben nur wenige Arten gemeinsam. Sie sind voneinander getrennt durch die zentralanatolischen Steppen und Wüsten.

Fast ein Viertel der Arten des Vorderen Orients ist auch über die mehr nördlich gelegenen und kühleren Gebiete Europas verbreitet. Sie finden sich vorwiegend im östlichen Faunengebiet des Vorde-

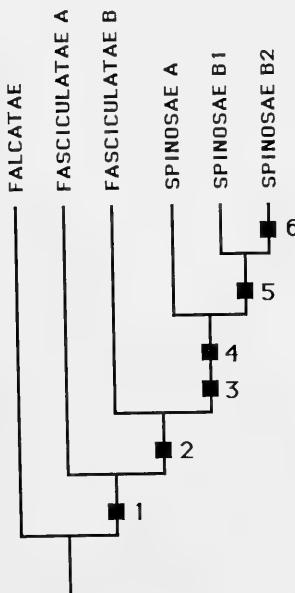


Fig. 3. Kladogramm der paläarktischen Hauptgruppen von *Lunatipula*.

ren Orients und es ist anzunehmen, daß die meisten europäischen und eurasischen Arten sich im Spätpleistozän oder im Holozän von der Balkanhalbinsel über Südrussland dorthin ausgebreitet haben.

Fast die Hälfte der Arten des Vorderen Orients gehören zu hochdifferenzierteren Artengruppen von *Lunatipula*, einer Untergattung von *Tipula*, die sich dort seit etwa dem Unteren Miozän entwickelt hat.

LITERATURVERZEICHNIS

Mannheims, B., 1963. 15. Tipulidae. — In: E. Lindner (Ed.): Die Fliegen der palaearktischen Region, 3 (5) 1, Lief. 238: 137-176.

Mannheims, B., 1965. Idem, Lief. 256: 177-212.

Mannheims, B., 1966. Idem, Lief. 267: 213-256.

Mannheims, B., 1967. idem, Lief. 270: 257-288.

Mannheims, B., 1968. Idem, Lief. 275: 289-320.

Parent, G. H., 1988. Esquisse biogéographique de la Crète. — Linneana Belgica 9: 344-387.

Riedel, M. P., 1913. Die palaearktischen Arten der Dipteren-Gattung *Tipula* L. — Abhandlungen des Vereins für naturwissenschaftliche Erforschung des Niederrheins, Krefeld 1: 1-122.

Rikli, M., 1943. Das Pflanzenkleid der Mittelmeerländer. Erster Band. — H. Huber, Bern: 1-436.

Rikli, M., 1946. Idem. Zweiter Band: 437-1094.

Rikli, M., 1948. Idem. Dritter Band: 1095-1418.

Savtshenko, E. N., 1964. Tipulidae. — Fauna SSSR (New Series), Diptera 2 (4) 89: 1-503.

Theowald, Br. & P. Oosterbroek, 1980. Zur Zoogeographie der westpalaearktischen Tipuliden. I. Die Tipuliden von Nordafrika. — Beaufortia 30: 179-192.

Theowald, Br. & P. Oosterbroek, 1981. Idem. II. Die Tipuliden der iberischen Halbinsel. — Beaufortia 31: 1-20.

Theowald, Br. & P. Oosterbroek, 1982. idem. IV. The Tipulidae of Corsica and Sardinia with a note on Dolichopeza fuscipes Bergroth. — Mitteilungen der schweizerischen entomologischen Gesellschaft 55: 317-332.

Theowald, Br., C. Dufour & P. Oosterbroek, 1983. Idem. III. Die Tipuliden der europäischen Tiefebenen. — Bonner zoologische Beiträge 34: 371-394.

Theowald, Br. & P. Oosterbroek, 1984. Idem. V. Die italienischen Tipuliden. — Fragmenta entomologica Roma 17: 245-291.

Theowald, Br. & P. Oosterbroek. 1985. Idem. VI. Die Tipuliden der montanen, alpinen und borealen Gebiete. — Bonner zoologische Beiträge 36: 185-220.

Theowald, Br. & P. Oosterbroek, 1986. Idem. VII. Die Tipuliden der Balkanhalbinsel. — Tijdschrift voor Entomologie 129: 1-13.

Theowald, Br. & P. Oosterbroek, 1987. Idem. VIII. The Tipulidae of Israel and adjacent regions. — Israel Journal of Entomology 20: 71-83.

Theowald, Br. & P. Oosterbroek, 1990. Idem. X. The Tipulidae of the Eastmediterranean islands. — Bijdragen tot de Dierkunde (in press).

APPENDIX 1: Artenliste

Ctenophora

1. *elegans* Meigen, 1818: 2 (Sa)-E
2. *guttata* Meigen, 1818: 1 (28), 4 (67), 6-EA
3. *magnifica* Loew, 1869: 6, 9-eEA
4. *ornata* Meigen, 1818: 2 (29)-E

Dictenidia

5. *bimaculata* (Linnaeus, 1761): 5 (58), 6, 9-EA

Dolichopeza

6. *fuscipes* Bergroth, 1889: 2 (Sa)-M
7. *graeca* Mannheims, 1954: 4 (59), 5 (58)-M
8. *hirsuticauda* Savtshenko, 1968: 6, 7-eM
9. *schabriari* Theowald, 1978: 9-eM

Nephrotoma

cornicina-Gruppe

10. *aculeata* (Loew, 1871): 4 (64), 5 (40, 56), 6, 7-EA
11. *appendiculata appendiculata* (Pierre, 1919): 1 (21, 28), 3 (27), 4 (63, 64), 5 (25, 57), 6, 7, 8, 9-E
12. *beckeri* (Mannheims, 1951): 2 (Cy, 29, 30, Li, Is), 4 (50)-eM
13. *cornicina* (Linnaeus, 1758): 1 (20, 21, 28), 2 (Sa, Cy, Li, Is), 3 (34, 35), 4 (50, 59, 60, 61), 5 (25, 41, 55, 58), 6, 7, 8, 9-EA
14. *eugenica* (Savtshenko, 1957): 6-eEA
15. *guestfalica* (Westhoff, 1880): 2 (14)-E
16. *minuscula* (Mannheims, 1951): 2 (Cy, 30, Sy, Li, Is)-eE
17. *nasuta* Oosterbroek, 1975: 1 (7, 28), 4 (64)-eM
18. *quadrifaria quadrifaria* (Meigen, 1804): 7-E
19. *quadrifaria farsidica* (Savtshenko, 1957): 9-eE
20. *schaueffelei* (Mannheims, 1964): 7, 9-eM
21. *tenuipes* (Riedel, 1910): 6-EA
22. *theowaldi* Oosterbroek, 1978: 1 (28), 2 (Ko, Ro, 14, 15, 19, 29)-eE

crocata-Gruppe

23. *analis* (Schummel, 1833): 1 (21, 28), 3 (35, 37), 4 (59, 62, 63, 64), 5 (57), 6, 7, 8, 9-EA
24. *crociventris lindneri* (Mannheims, 1951): 2 (Ko, 33), 3 (27, 34, 35), 4 (46, 61, 62, 63, 64, 65, 67), 5 (23, 57), 7, 8-E
25. *nox* (Riedel, 1910): 1 (28), 3 (35), 4 (48, 50, 59, 60, 61, 64, 65, 66, 67), 7, 8, 9-eEA
26. *pratensis* (Linnaeus, 1758): 5 (56), 6, 8-E
27. *scalaris scalaris* (Meigen, 1818): 1 (7, 21), 2 (Ik, Ro, Cy, 14, 19, 30, Sy, Li, Is), 3 (34), 4 (50, 59, 63, 64, 65), 5 (45, 56, 57), 6, 7, 8, 9-EA
28. *scalaris terminalis* (Wiedemann, 1830): 5 (58), 6, 7, 8, 9-A

Nigrotipula

29. *nigra* (Linnaeus, 1758): 7-EA

Tipula

T. (Acutipula)

- 30. *cypriensis* Vermoolen, 1983: 2 (Cy)-eM
- 31. *fulvipennis fulvipennis* De Geer, 1776: 4 (59), 5 (58), 6, 7, 9-EA
- 32. *fulvipennis nigroantennata* Savtshenko, 1961: 5 (45, 58), 6, 7, 9-eEA
- 33. *isparta* Vermoolen, 1983: 1 (20), 2 (Cy, 29)-eM
- 34. *irrequia* Alexander, 1935: 7, 8, 9-A
- 35. *libanica* Vermoolen, 1983: 2 (Li, Is)-eE
- 36. *macra* Savtshenko, 1961: 7, 9-eM
- 37. *transcaucasica transcaucasica* Savtshenko, 1961: 8, 9-M
- 38. *transcaucasica latifurca* Vermolen, 1983: 1 (21, 28), 2 (Ik, Sa, Ko, 19, 31, Li), 4 (63, 64, 65, 67), 5 (56, 57)-M

T. (Beringotipula)

- 39. *unca* Wiedemann, 1817: 6, 7, 8-EA

T. (Dendrotipula)

- 40. *flavolineata* Meigen, 1804: 6, 7, 8-E

T. (Emodotipula)

- 41. *saginata* Bergroth, 1891: 4 (59), 8, 9-E

T. (Lunatipula)

acuminata-Gruppe

- 42. *angela* Mannheims, 1963: 2 (Li, Is)-eM
- 43. *angelica* Theowald, 1957: 2 (Sy, Li, Is)-eM
- 44. *artemis artemis* Theischinger, 1977: 2 (Kh, Ik, Sa)-M
- 45. *artemis asiaeminioris* Theischinger, 1982: 2 (14, 15)-eM
- 46. *auriculata* Mannheims, 1963: 2 (31)-eM
- 47. *berytia* Mannheims, 1963: 2 (Li, Is)-eM
- 48. *borysthenica* Savtshenko, 1952: 1 (28)-M
- 49. *brinki* Theischinger, 1987: 2 (19)-eM
- 50. *canakkalensis* Theischinger, 1987: 1 (5)-eM
- 51. *curvata* Theischinger, 1977: 2 (31)-eM
- 52. *cypris* Mannheims, 1963: 2 (Ro, Cy)-eM
- 53. *decolor* Mannheims, 1963: 1 (7, 9)-M
- 54. *dedecor* Loew, 1873: 2 (Sa, Ko)-eM
- 55. *emmabellene* Theischinger, 1980: 2 (29)-eM
- 56. *franzressli* Theischinger, 1982: 2 (16)-eM
- 57. *geja* Savtshenko, 1968: 6-eM
- 58. *horsti* Theischinger, 1982: 1 (18), 2 (19)-eM
- 59. *huberti* Theischinger, 1982: 2 (19)-eM
- 60. *hyrcana* Savtshenko, 1973: 7-eM
- 61. *istriana* Erhan & Theowald, 1961: 1 (Le, 9, 10, 18, 21, 28)-M
- 62. *kaplani* Theowald & Oosterbroek, 1987: 2 (Is)-eM
- 63. *kreissli* Theischinger, 1987: 5 (25)-eM
- 64. *leeuweni* Theischinger, 1982: 2 (Sy, Is)-eM
- 65. *macropyga* Savtshenko, 1952: 8, 9-eM
- 66. *montifer montifer* Theischinger, 1977: 2 (31)-eM

67. *montifer tascuensis* Theischinger, 1987: 2 (29)-eM

68. *musensis* Theischinger, 1987: 4 (63)-eM

69. *osmana* Mannheims, 1963: 1 (7), 5 (40), 6, 7-eM

70. *parasimurg* Savtshenko, 1968: 7-eM

71. *peteri* Theischinger, 1979: 1 (7)-eM

72. *simurg* Savtshenko, 1964: 7-eM

73. *subacuminata* Mannheims, 1963: 2 (29, 31, 33), 4 (60, 64)-eM

74. *suleika* Mannheims, 1963: 7, 9-eM

75. *theowaldi* Savtshenko, 1964: 6-eM

76. *turca* Mannheims, 1963: 1 (7)-eM

77. *valerii* Savtshenko, 1968: 6-eM

78. *vermooleni* Theischinger, 1987: 2 (Ko)-eM

adusta-Gruppe

- 79. *adusta lucistriata* Mannheims & Savtshenko, 1967: 2 (31), 4 (61)-A

caucasica-Gruppe

- 80. *caucasica* Riedel, 1920: 6-eM
- 81. *kinzelbachi* Theischinger, 1982: 2 (Sy)-eM
- 82. *quadridentata paupera* Savtshenko, 1964: 6-eM
- 83. *talysensis* Savtshenko, 1964: 7-eM

clio-Gruppe

- 84. *chelifera* Savtshenko, 1964: 4 (59), 5 (58), 6-eM

fasciungulata-Gruppe

- 85. *eugeniana* Simova-Tosic, 1972: 6-M
- 86. *praecox* Loew, 1873: 6-M
- 87. *rhynchos* Theischinger, 1977: 2 (14)-eM

fascipennis-Gruppe

- 88. *fascipennis* Meigen, 1818: 6-E

helvola-Gruppe

- 89. *helvola* Loew, 1873: 1 (Le, 7, 28), 2 (Sa, 16, 19, Is), 5 (56)-E

laetabilis-Gruppe

- 90. *humilis* Staeger, 1840: 6-E

livida-Gruppe

- 91. *adzharolivida* Savtshenko, 1968: 6-eM
- 92. *bimacula bimacula* Theowald, 1980: 1 (Le), ?9-M
- 93. *cinerella* Pierre, 1919: 1 (20, 28), 2 (19)-M
- 94. *deserticola* Savtshenko, 1968: 7-eM
- 95. *freidbergi* Theowald & Oosterbroek, 1987: 2 (Is)-eM
- 96. *kumerloevi* Mannheims, 1968: 2 (31)-eM
- 97. *kybele kybele* Mannheims, 1968: 1 (28), 2 (29, Li, Is), 3 (35), 4 (63, 64, 66, 67)-eM
- 98. *kybele russula* Theischinger, 1977: 1 (18, 20, 28), 2 (19)-eM

99. *livida morosa* Savtshenko, 1964: 6-eE
 100. *maijs* Savtshenko, 1973: 6-eM
 101. *mendli* Martinovsky, 1976: 1 (Le, 7, 17, 21), 2 (Kh, Ko, Sa, 16)-eM
 102. *nigdeensis* Bischof, 1905: 3 (28a, 35)-eM
 103. *pseudowolfi* Theischinger, 1979: 1 (28), 2 (Sa, 16)-eM
 104. *rhodolivida* Theowald, 1972: 2 (Ko, Ro, 16, 19)-eM
 105. *saltatrix* Savtshenko, 1964: 6-eM
 106. *sternalis* Theischinger, 1977: 2 (Is), 4 (64)-eM
 107. *trapeza* Theischinger, 1982: 1 (21)-eM
 108. *turcolivida* Mannheims, 1968: 2 (31)-eM
 109. *vulpecula* Theischinger, 1979: 4 (65), 5 (56)-eM

lunata-Gruppe

110. *furcula* Mannheims, 1964: 1 (5, 7, 21, 28), 2 (Kh, Ko, Ro, 14, 15, 16)-M
 111. *hybrida hybrida* Savtshenko, 1952: 7-eM
 112. *hybrida altivolans* Savtshenko, 1971: 6-eM
 113. *lunata* Linnaeus, 1758: 6, 7, 8-E
 114. *paravelox* Theischinger, 1987: 2 (33)-eM
 115. *pseudolunata pseudolunata* Theischinger, 1980: 1 (21, 28)-eM
 116. *pseudolunata spinalonga* Theischinger, 1982: 6-eM
 117. *soosi soosi* Mannheims, 1954: 1 (Le, 5, 7, 18, 20, 21, 28), 2 (Sa, Ro, 14, 15, 16, 19, 29, 31), 3 (34, 35), 6-M
 118. *soosi izmirensis* Theischinger, 1987: 2 (14)-eM
 119. *subvelox* Savtshenko, 1968: 5 (25), 6-eM
 120. *unicornis* Theischinger, 1977: 5 (25, 43)-eM

macroselene-Gruppe

121. *acudens* Theischinger, 1977: 2 (33)-eM
 122. *adapazariensis* Theischinger, 1987: 1 (8)-eM
 123. *aurita* Riedel, 1920: 6, 7, 8-eM
 124. *carens* Theischinger, 1987: 1 (8)-eM
 125. *cedrophila* Mannheims, 1963: 1 (10), 2 (Ro, Li, Is)-eM
 126. *christophi* Theischinger, 1982: 2 (Sa, 14)-eM
 127. *dumetorum* Savtshenko, 1964: 6-eM
 128. *holzschuhii* Theischinger, 1977: 9-eM
 129. *iliensis* Mannheims, 1965: 2 (31)-eM
 130. *imbecilla* Loew, 1869: 2 (Ro)-eM
 131. *kerkis* Theischinger, 1977: 1 (21)-eM
 132. *lithophila* Savtshenko, 1968: 7-eM
 133. *lucasi* Theischinger, 1987: 4 (67)-eM
 134. *oorschotorum* Theischinger, 1987: 1 (21)-eM
 135. *palifera* Mannheims, 1965: 2 (19, 33), 3 (35)-eM
 136. *rutila* Savtshenko, 1952: 2 (33), 8-eM
 137. *selenis* Loew, 1873: 2 (Ro)-eM
 138. *subbispinia* Savtshenko, 1952: 9-eM
 139. *tibonella* Theischinger, 1977: 1 (Le, 11), 2 (14, 19)-M

140. *zaitzevi* Savtshenko, 1952: 6, 8-eM

mellea-Gruppe

141. *affinis* Schummel, 1833: 6-E

peliosigma-Gruppe

142. *antilope* Theischinger, 1977: 4 (67), 9-eM
 143. *astigma* Savtshenko, 1968: 6-eM
 144. *didymotes* Theischinger, 1977: 4 (61, 64, 65, 67)-eM
 145. *micropeliosigma* Mannheims, 1965: 1 (21)-eM
 146. *ornithogona* Theischinger, 1982: 2 (16)-eM
 147. *peliosigma peliosigma* Schummel, 1833: 1 (18), 2 (Sa, Is, 15), 3 (28, 37), 6, 7, 8-E
 148. *peliosigma burdurafyonensis* Theischinger, 1987: 1 (18, 21)-eE
 149. *pseudopeliosigma* Mannheims, 1965: 2 (Li, Is)-eM
 150. *renate* Theischinger, 1982: 1 (18)-eM
 151. *selene* Meigen, 1830: 6-E
 152. *semipeliosigma* Mannheims, 1965: 2 (31)-eM
 153. *strigosa* Savtshenko, 1952: 5 (58), 6-eM
 154. *ulrike* Theischinger, 1982: 1 (28)-eM
 155. *ursulae* Mannheims, 1965: 2 (19)-eM

phaidra-Gruppe

156. *cressa* Mannheims, 1965: 2 (Ro)-M
 157. *sciurus* Theischinger, 1977: 1 (20, 28), 2 (19, 31)-eM

truncata-Gruppe

158. *arnoldii* Savtshenko, 1957: 6-M

verrucosa-Gruppe (= *brunneinervis*-Gruppe)

159. *dracula* Theischinger, 1977: 1 (21), 2 (Kh, Ko, 16)-eM
 160. *neutra* Theischinger, 1982: 1 (28), 2 (19)-eM
 161. *quinquespinis* Theischinger, 1980: 1 (Le, 17, 18, 28), 2 (16, 19, 29)-eM
 162. *teunisseni* Theischinger, 1979: 2 (Ro)-eM
 163. *verrucosa verrucosa* Pierre, 1919: 6, 7, 8-M
 164. *verrucosa sinedente* Theischinger, 1980: 1 (17, 21, 28), 2 (30, Is), 3 (27), 4 (46), 5 (24, 43, 55)-eM

zimini-Gruppe

165. *zimini semiopaca* Savtshenko, 1964: 7-A

T. (*Mediotipula*)

166. *anatoliensis* Theowald, 1978: 1 (28)-eE
 167. *caucasiensis* Theowald, 1978: 6-eE
 168. *stigmatella* Schummel, 1833: 1 (7), 8-E

T. (*Pterelachisus*)

169. *luteobasalis luteobasalis* Savtshenko, 1964: 4 (64), 5 (58), 6, 8, 9-eE
 170. *luteobasalis alata* Theowald, 1980: 4 (64)-eE

171. *trichopleura* Savtshenko, 1964: 6-eE

T. (Savtshenkia)

172. *baltistanica* Alexander, 1935: 6, 7-A

173. *interserita* Riedel, 1913: 6, 7, 8-E

174. *jeekeli* Mannheims & Theowald, 1959: 1 (Le), 2 (Ro)-M

175. *nivalis* Savtshenko, 1961: 6-eEA

176. *obsolete* Meigen, 1818: 5 (56), 6-E

177. *ornata* Theowald & Oosterbroek, 1987: 2 (Is)-eE

178. *pechlaneri* Mannheims & Theowald, 1959: 9-E

179. *rufina rufina* Meigen, 1818: 2 (Cy, Li, Is), 4 (67), 7, 9-E

180. *serrulifera* Alexander, 1942: 5 (58), 6-E

181. *subalpium* Savtshenko, 1961: 6-eE

T. (Schummelia)

182. *ahrensi* Savtshenko, 1957: 6-eE

183. *varicornis* Schummel, 1833: 8-E

T. (Tipula)

184. *italica errans* Theowald, 1984: 1 (Le), 5 (56), 7, 8, 9-M

185. *oleracea* Linnaeus, 1758: 2 (Ro)-E

186. *orientalis* Lackschewitz, 1930: 1 (Le, 5, 18, 20, 21, 28), 2 (Ko, Ro, Cy, 14, 15, 16, 29, Sy, Li, Is, Äg), 3 (34), 4 (46, 48, 59, 63, 64, 65), 5 (41, 44, 58), 6, 7, 8, 9-M

187. *subcunctans* Alexander, 1921: 8-EA

T. (Vestiplex)

188. *kosswigi* Mannheims, 1953: 1 (7)-eA

189. *pallidicosta pullata* Savtshenko, 1960: 1 (28), 4 (61), 5 (56), 6, 7, 8-eE

190. *relicta* Dia & Theowald, 1982: 2 (Li, Is)-eA

191. *semivittata semivittata* Savtshenko, 1960: 5 (45, 58), 6, 7-E

192. *semivittata dissimilis* Savtshenko, 1964: 6-eE

T. (Yamatotipula)

193. *caesia* Schummel, 1833: 1 (17, 21, 28), 3 (27), 4 (59, 63, 64), 6-E

194. *caucasimontana* Savtshenko, 1955: 4 (67), 7-eA

195. *lateralis lateralis* Meigen, 1818: 1 (7, 17, 18, 20, 21, 28), 2 (Sa, Ik, Ko, Ro, 19, 29, 31, 33, Sy, Li, Is), 3 (27), 4 (46, 49, 50, 59, 60, 64, 67), 5 (24, 56), 6, 8-E

196. *lateralis iranensis* Theowald, 1978: 4 (64), 9-eE

197. *pruinosa* Wiedemann, 1817: 6-EA

198. *submontium* Theowald & Oosterbroek, 1981: 1 (7), 2 (31, 33, Sy), 4 (64, 65, 67), 5 (45), 6, 8-E

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BOOK REVIEW

Johansson, R., E. S., Nielsen, E. J. van Nieukerken and B. Gustafsson, 1989. The Nepticulidae and Opostegidae (Lepidoptera) of North West Europe. – Fauna Entomologica Scandinavica 23: 1-739, text-figs. 1-111, tables 1-3, figs. 1-1122. [ISBN 90 04 08698 6 (2 parts), E. J. Brill, Leiden, The Netherlands. Price 220 Dutch Guilders/US \$ 110.-].

For the first time an up to date treatment is given for all the 121 species of Nepticulidae and four species of Opostegidae occurring in Fennoscandia, Denmark, the British Isles, The Netherlands, Belgium, France north of Paris, West and East Germany, Poland and the Baltic states. This two volume work figures in full colour all species and gives additional colour illustrations in cases of sexual dimorphism or polymorphism. The colour illustrations are of very high quality and make the book even more a must for specialists, lepidopterists in general and book-lovers alike. Line drawings of male and female genitalia and leaf-mines for all species are given. Also the larvae of most species are figured.

Identification of the species is facilitated by various keys: key to the tribes and families of Nepticuloidea; key to the mines and larvae, arranged per host plant genus; keys to the males, based on external characters; keys to the males, based on genitalia; keys to the females, based on external characters and keys to the females, based on genitalia. Unfortunately the key for the females of Nepticulini (the first 76 species) based on the genitalia would be too much a copy of the full descriptions and has been omitted. But upon checking the line drawings of the female genitalia a definite identification is easily reached.

Each species is fully redescribed and biology and distribution given. The chapters on immature stages, biology, collecting and rearing, will undoubtedly stimulate many people to keep an eye out for the mines of the Nepticulidae.

The phylogeny, classification and nomenclature are briefly, but adequately, dealt with in a separate chapter. One minor point to be mentioned in the section which deals with the Nepticulini is the lacking of the flight periods for the adults and the months in which the larvae can be found. This in contrary to the other part of the book where this information is given. This book has a very high scientific standard, but is easily accessible for the non-specialist at the same time.

[R.T.A. Schouten]

KEY TO THE MALESIAN SPECIES OF *LEPTOGOMPHUS* SELYS, WITH THE DESCRIPTION OF A NEW SPECIES FROM SABAH (ODONATA, GOMPHIDAE).

Descriptions and records of Malesian Odonata, 1.

Tol, J. van, 1990. Key to the Malesian species of *Leptogomphus* Selys, with the description of a new species from Sabah (Odonata, Gomphidae). Descriptions and records of Malesian Odonata, 1. — Tijdschrift voor Entomologie 133: 97-105, figs. 1-37, tabs 1-2 [ISSN 0040-7496]. Published 31 July 1990.

A new species of *Leptogomphus*, *L. pasia*, based on one female from S. Sabah (Northern Borneo), is described. A congeneric and presumably conspecific male from E. Sabah is also described. A key to the eleven species of this genus recorded from Malaysia, Indonesia, the Philippine Islands, and the adjacent areas in Burma and Thailand, is included. Many characters are illustrated for the first time.

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Key words. — *Leptogomphus*; key; Malesia; new species.

INTRODUCTION

During the 1987 expedition of the Rijksmuseum van Natuurlijke Historie (Leiden) to Sabah, northern Borneo, a wealth of interesting Odonata was collected. In this paper a new species of *Leptogomphus* Selys is described, based on a single female. It was collected in the vicinity of Long Pasia, a village still surrounded by vast areas of virgin rainforest. This area, situated close to the borders of Sarawak and Kalimantan at c. 1000 m above sea level, is poorly investigated for the aquatic fauna up to now. The Odonata fauna seems to be most closely related to those of Mount Dulit and other higher peaks in Sarawak. This may be exemplified by records of *Coelicia cyaneothorax* Kimmins, formerly only known from Mt. Dulit, and *Burmagomphus insularis* Laidlaw, of which only the holotype from Sarawak was known. A complete list of the species encountered will be published in due time.

SYSTEMATIC PART

Leptogomphus pasia spec. nov. (Figs. 1-6, 8, 16, 32-33)

Type material. — Holotype female: 'RMNH Leiden/N. Borneo, S. SABAH. Beaufort, 105 km S of: Long Pasia area. Sungai Pasia near confluence with Sungai Maga. Rockpools and stream. Lower montane evergreen tropical rainforest. 1250 m.'

4°26'N 115°40'E. 3 April 1987. Leg. C. van Achterberg', in Museum Leiden (RMNH).

Other material. — Sabah, 60 km W of Lahad Datu: Danum Valley Field Centre, 4°58'N 117°48'E. 2 May 1987, 1 male (J. van Tol) in RMNH.

Description

Female. — Closely related to *Leptogomphus lansbergei* and *L. semperi*, but immediately recognizable by its extremely long vulvar lamina (vulvar scale) (authors of species-group names in *Leptogomphus* are given in table 1).

Head. — Depressed; frons, clypeus and labrum protruding. Labium with prementum dark brown to brownish black, lateral lobes greenish yellow, broadly bordered with brownish black, especially distally; movable hooks brownish black, central part of mentum pale brown, laterally bordered with creamish white. Mandibles reddish brown-black, but visible part beside the labrum mostly greenish yellow. Labrum black with two relatively small subtriangular pale spots close to the clypeus. Clypeus black, with a paired oval depression on postclypeus, together approximately as wide as clypeus between the emarginate anterior side. Frons distinctly swollen with a broad greenish yellow transversal stripe, covering nearly half of the surface, pale stripe interrupted in the middle by a dark triangular

Table 1 Species included in the key of the *Leptogomphus* species of Malesia, with original references

Species	Author; date: pages	Original genus	Type depository
<i>L. coomansi</i>	Laidlaw 1936: 267-269	<i>Leptogomphus</i>	RMNH / H male
<i>L. gestroi</i>	Selys 1891: 476-477	<i>Leptogomphus</i>	MCSN / H male
<i>L. inclitus</i>	Selys 1878: 444 (sep 39)	<i>Gomphus</i> (<i>Leptogomphus</i>)	BMNH / L female
<i>L. lansbergei</i>	Selys 1878: 446 (sep 41)	<i>Gomphus</i> (<i>Leptogomphus</i> ?)	IRSN + SMTD / S female
<i>L. lansbergei assimilis</i>	Krüger 1899: 308	<i>Leptogomphus</i>	ZMPA ? / S male + female
<i>L. mariae</i>	Liefstink 1948: 249-251	<i>Leptogomphus</i>	RMNH / H female
<i>L. palawanus</i>	Asahina 1968: 364-365	<i>Leptogomphus</i>	CASC / H male
<i>L. pendleburyi</i>	Laidlaw 1934: 555-556	<i>Leptogomphus</i>	BMNH / H male
<i>L. risi</i>	Laidlaw 1933: 95-96	<i>Leptogomphus</i>	BMNH / H male
<i>L. semperi</i>	Selys 1878: 443 (sep 38)	<i>Gomphus</i> (<i>Leptogomphus</i>)	IRSN / H male
<i>L. williamsoni</i>	Laidlaw 1912: 94-95	<i>Leptogomphus</i>	BMNH / H male

Abbreviations: BMNH = British Museum (Natural History), London; CASC = California Academy of Sciences, San Francisco; IRSN = Institut Royal des Sciences Naturelles de Belgique, Bruxelles; MCSN = Museo Civico di Storia Naturale, Genoa; RMNH = National Museum of Natural History, Leiden; SMTD = Staatliches Museum für Tierkunde, Dresden; ZMPA = Zoological Museum Polish Academy of Sciences, Warszawa. - H = holotype, L = lectotype, S = syntype.

Note: The type of *L. assimilis* should be selected from material in the Dohrn collection, which was deposited in Stettin (now Szczecin, Poland); some parts of the collection of this museum have been transferred to ZMPA.

emargination. Vertex shiny black, but dullish black behind the tubercles posterior to the lateral ocelli; occiput also dull black, tubercles behind lateral ocelli consisting of a larger pair in the centre between the ocelli and a smaller pair latero-posteriorly of the former; occiput without tuberculi (fig. 2), which are usually present in congeneric species (e.g. *L. semperi*, *L. coomansi*, *L. mariae* and *L. williamsoni*) (see also Liefstink 1948, plate 8); occiput posteriorly with a distinct triangular emargination.

Thorax (for nomenclature of thoracic markings, cf. Williamson 1907: fig. 29 (1)). - Prothorax with anterior lobe erect, black, but greenish yellow in lateral edges; middle lobe with deep median depression anteriorly. Synthorax (fig. 5) brownish black with pale markings yellow; dorsal thoracic stripe connected with mesothoracic half collar (as in *L. coomansi*); antehumeral stripe narrow, somewhat wider at posterior side; pale markings on mesepimeron and metepisternum more or less as in *L. lansbergei*, but pale area on metepimeron much smaller than in *L. lansbergei* (the dark stripe under the pale area approximately of equal width). Legs stoutly built; hind femora with two rows of 9-12 distinct short spines on innerseite; all tibiae with two rows of 9-10 long spines on innerseite. Wings: forewing 37 mm, hind wing 35 mm. Forewing with 16 Ax and 13 Px; hindwing with 12 Ax and 13 Px. Hind wing with one cubito-anal crossvein; an incomplete crossvein proximal to first primary Ax present; distal costal brace closer to proximal costal brace than to nodus; triangle, supratriangle and subtriangle all without crossveins. Pterostigma 3.5 mm.

Abdomen. — Length 39 mm. Dark brown, nearly black, except for a yellow middorsal stripe, which is rather wide on segments 1-2, but much narrower to

nearly indiscernable on segments 3-8; lateral side of segment 1 dark yellow, lateral side of segment 2 and antero-lateral side of segment 3 also dark yellow. Auriculae hardly developed, yellow. Vulvar lamina diagnostic (figs. 3-4), extremely elongate, the tip reaching posterior margin of segment 10, very slender, the top acutely v-shaped.

Male. — As female (figs. 6, 16), but pale spots on labrum larger than in female, subquadangular (fig. 8); hind femora with many short spines on inner-side instead of the rows of medium-sized spines as in the female; wings with anal triangle three-celled, crossveins meeting in one point; secondary genitalia and anal appendages very similar to *L. lansbergei*, but superior appendage of *lansbergei* in dorsal view curved outwards more conspicuous than in *pasia* (figs. 30, 32); base of superior appendage of *pasia* bulgy on outer margin; consequently, lateroventral ridge with spines along the outer margin of the superior appendage nearly straight in *lansbergei* and distinctly curved in *pasia* (figs. 31, 33).

Although I consider this male conspecific with the female described above, I prefer to include only the female in the type series of this species.

Differential diagnosis. — The female of this species, superficially looking as *L. lansbergei*, is most easily distinguished from its congeners by the peculiar shape of the vulvar lamina. Also the male is very similar to *L. lansbergei*, but can be distinguished from most species by the thoracic markings, and from *lansbergei* by the shape of the superior appendages.

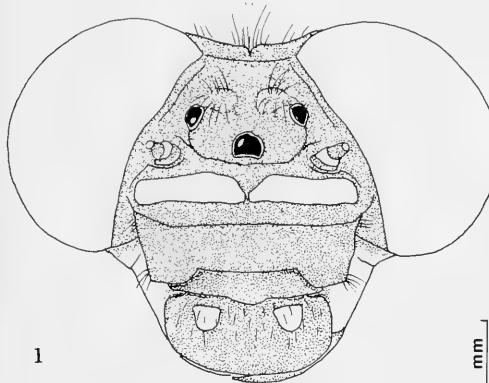
Etymology. — *Pasia* from the type locality Long Pasia. To be considered as a noun in apposition.

Discussion

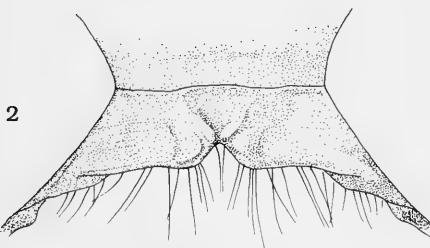
Up to now the following species of the genus *Leptogomphus* were known from Borneo: *L. coomansi*, *L. mariae*, *L. pendleburyi* and *L. williamsoni*. There is still some doubt about the occurrence of *L. lansbergei assimilis* on Borneo, of which a male was recorded from Bettutan, 4 August 1927 by Laidlaw (1931). This specimen is not in the collection of the British Museum (Natural History) (Brooks in litt.). Also *L. semperi*, known from Mindanao, should be

taken into account when considering the fauna of Borneo. Earlier records by Martin (1904) and Williamson (1907) were considered erroneous by Laidlaw (1936). This species was also attributed to the *lansbergei* Formenkreis by Laidlaw (1936).

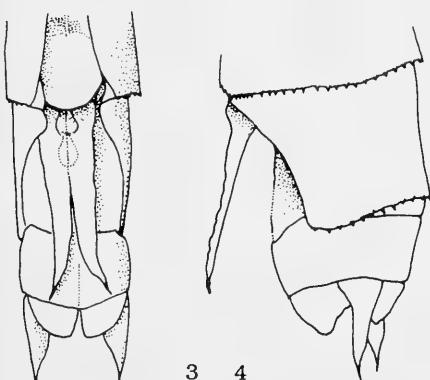
L. pasia shows some affinity to *L. coomansi* and *L. mariae*, sharing the connection between the dorsal stripe and the mesothoracic half collar (cf. Lief tinck 1948, plate 8). The absence of spiny tubercles on the occipital plate, and the peculiar shape of the



1



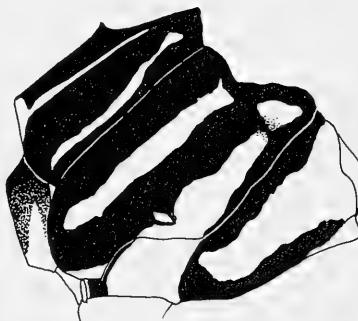
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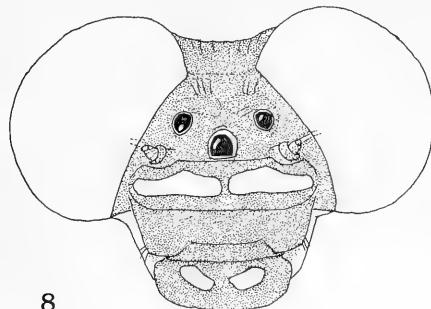


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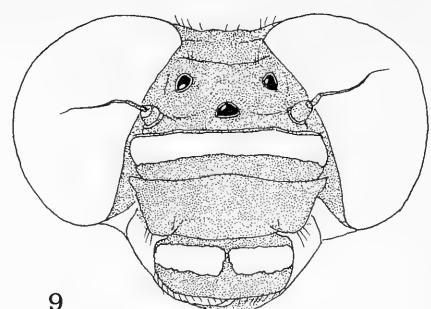


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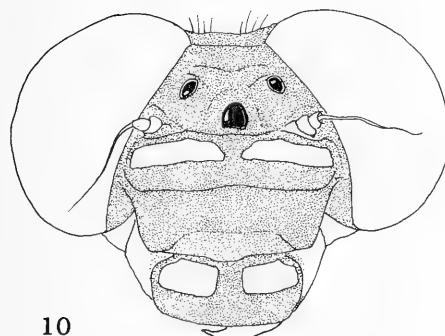
Figs. 1-7. *Leptogomphus* from northern Borneo. – 1, *L. pasia* female holotype, head in frontal view; 2, Idem, hind margin of occiput in dorsal view; 3-4, Idem, last abdominal segments in ventral and left lateral view; 5, Idem, synthorax in left lateral view; 6, *L. cf. pasia*, male from Danum Valley, synthorax in left lateral view; 7, *L. pendleburyi*, male holotype, synthorax in left lateral view.



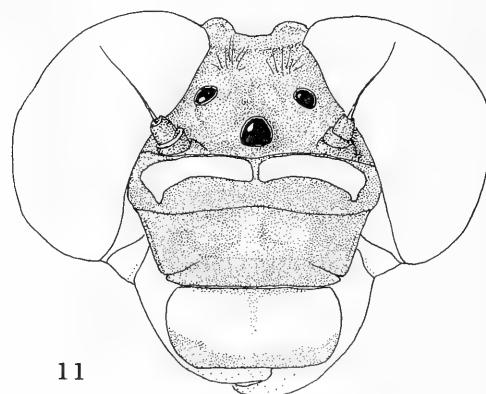
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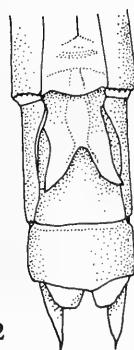
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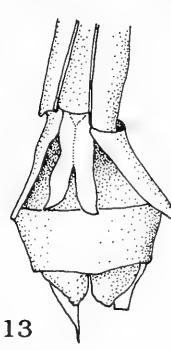
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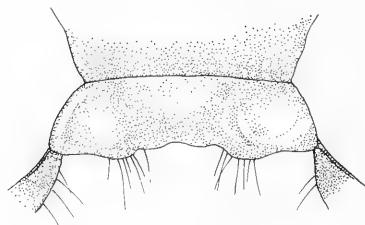
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Figs. 8-14. *Leptogomphus*. – 8, *L. cf. pasia*, male from Danum Valley, head in frontal view; 9, *L. pendleburyi*, male holotype, idem; 10, *L. lansbergei assimilis*, male from S. Sumatra, idem; 11, *L. inclitus*, female lectotype, head in frontal view; 12, *L. lansbergei assimilis*, female from S. Sumatra, last abdominal segments in ventral view; 13, *L. inclitus*, female lectotype, idem; 14, *L. inclitus*, female lectotype, hind margin of occiput in dorsal view.

vulvar scale are diagnostic characters for the presently described species. As already mentioned above, it is, however, most closely related to *L. lansbergei* from Java and Sumatra.

KEY TO THE *LEPTOGOMPHUS* SPECIES OF MALESIA

In the next key I have summarized the characters to distinguish the species of *Leptogomphus* occurring in Malesia (i.e. the Malay peninsula, Indonesia, the Philippine Islands and the island groups north-east of New Guinea). I have added several species recorded from Burma and Thailand that might occur in this area. All species mentioned in the key are listed in table 1 with the author and a reference to the original publication. *Leptogomphus svihleri* Asahina, however, recorded from Burma and Thailand, is not included in the key. The absence of an incomplete basal cross-vein (Asahina 1970: 116) is an indication that this species is not a *Leptogomphus* in the present sense. Asahina (1986: 17) has placed it in *Heliogomphus*. The genus *Leptogomphus* Selys as defined by Carle (1986) forms with *Africogomphus* Fraser and *Heliogomphus* Laidlaw the tribe Leptogomphini in the Epigomphinae. Characters to distinguish *Leptogomphus* and *Heliogomphus* include lamina on fore tibia of male (present/absent, respectively), basal subcostal crossvein (present/absent), cells of anal triangle in male (meet in one point/serially), lamina anterior (raised transverse-platelike/bilobate), superior appendages of male (more or less straight/lyrelike).

The key is mainly based on characters in the markings of the specimens, predominantly of the head and the thorax. Colour pattern is a reliable character in this group and the interpretation of

conspecificity is based on this character for several species. Structural characters include the appendages of the male and the vulvar scale of the female. Also the tubercles on vertex and occiput are frequently used, but these characters have to be considered carefully. I have seen several specimens with very apparent differences in the tubercles on each side of the head. Asahina (1986: 22) mentions female specimens of *L. gestroi* Selys with an occipital structure significantly different from the (allo) type. This phenomenon was also observed by him in *Merogomphus parvus*.

The distribution of the species was taken from the following works: for India in the wider sense (Laidlaw 1922, Fraser 1927, 1934), for Thailand (and Burma) (Williamson 1907, Asahina 1986), for Sumatra (Krüger 1899, Ris 1927, Lieftinck 1935, 1948), for Java (Lieftinck 1934), for Borneo (Laidlaw 1912, 1914, 1934, 1936, Lieftinck 1948) and for the Philippine Islands (Needham & Gyger 1937, Asahina 1968). Lieftinck (1954) is a most useful summary of knowledge for the larger part of this area.

Table 2 provides a data matrix for several important characters used in the dichotomous key below. I have examined all species myself.

1. Thorax with complete antehumeral stripe running close to the humeral suture (e.g. figs. 16-17, 19-21) 2
- Antehumeral stripe on thorax absent or strongly reduced, usually to a small pale spot in the posterior corner of the thorax above the humeral suture (e.g. figs. 15, 18) 10
2. (1) Vertex with yellow marking; transversal stripe on frons not interrupted by a longitudinal black line in the middle 3

Table 2

Species	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
coomansi	+	+	—	+	—	—	—	+	+
gestroi	+	—	—	—	+	+	—	?	—
inclusus	+	—	+	—	—	+	—	±	?
lansbergei lansbergei	+	—	+	—	—	+	—	—	+
lansbergei assimilis	+	—	+	—	—	+	—	—	+
mariae	+	+	+	—	—	r	—	+	?
palawanus	+	+	±	—	—	r	—	+	+
pasia	+	+	±	—	—	+	+	—	(+)
pendleburyi	+	+	—	—	—	r	?	?	+
risi	+	+	+	—	—	—	—	—	±
semperi	+	+	+	—	—	+	—	+	+
williamsoni	—	±	—	+	+	+	—	+	?

(1) Dorsal stripe complete (+) / incomplete (—)

(2) Dorsal stripe connected (+) / not connected (—) with mesothoracic half collar

(3) Yellow mark on frons separate (+) / one stripe (—)

(4) Anterior side of postclypeus with yellow patches (+) / dark (—)

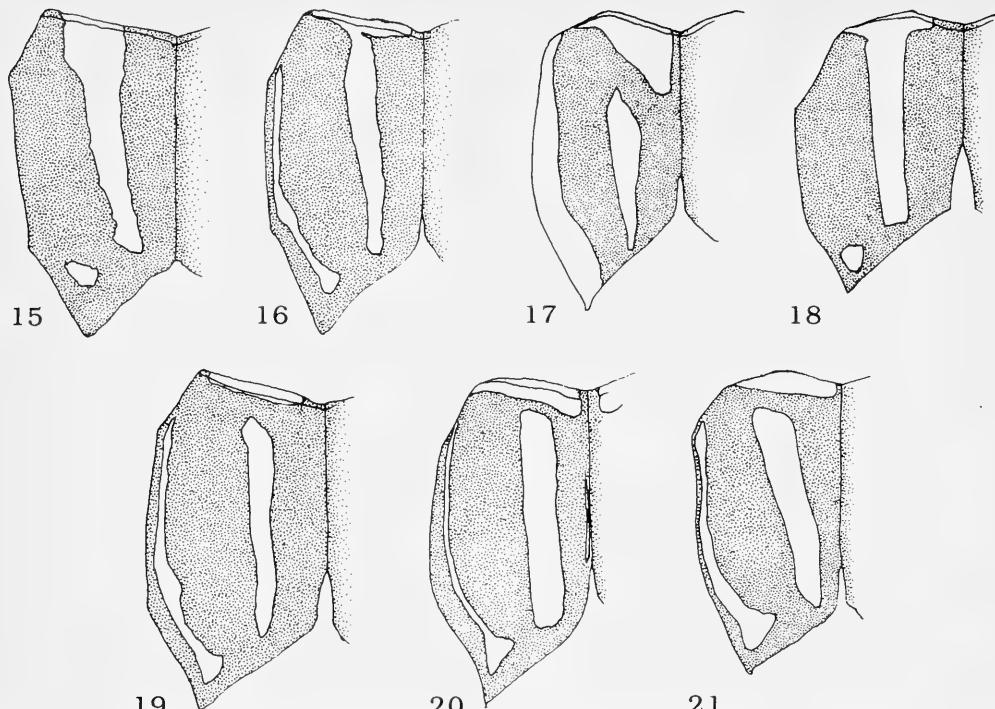
(5) Yellow mark on vertex present (+) / absent (—)

(6) Antehumeral stripe present (+) / absent (—) / reduced (r)

(7) Valve (female) far beyond segment 9 (+) / shorter (—)

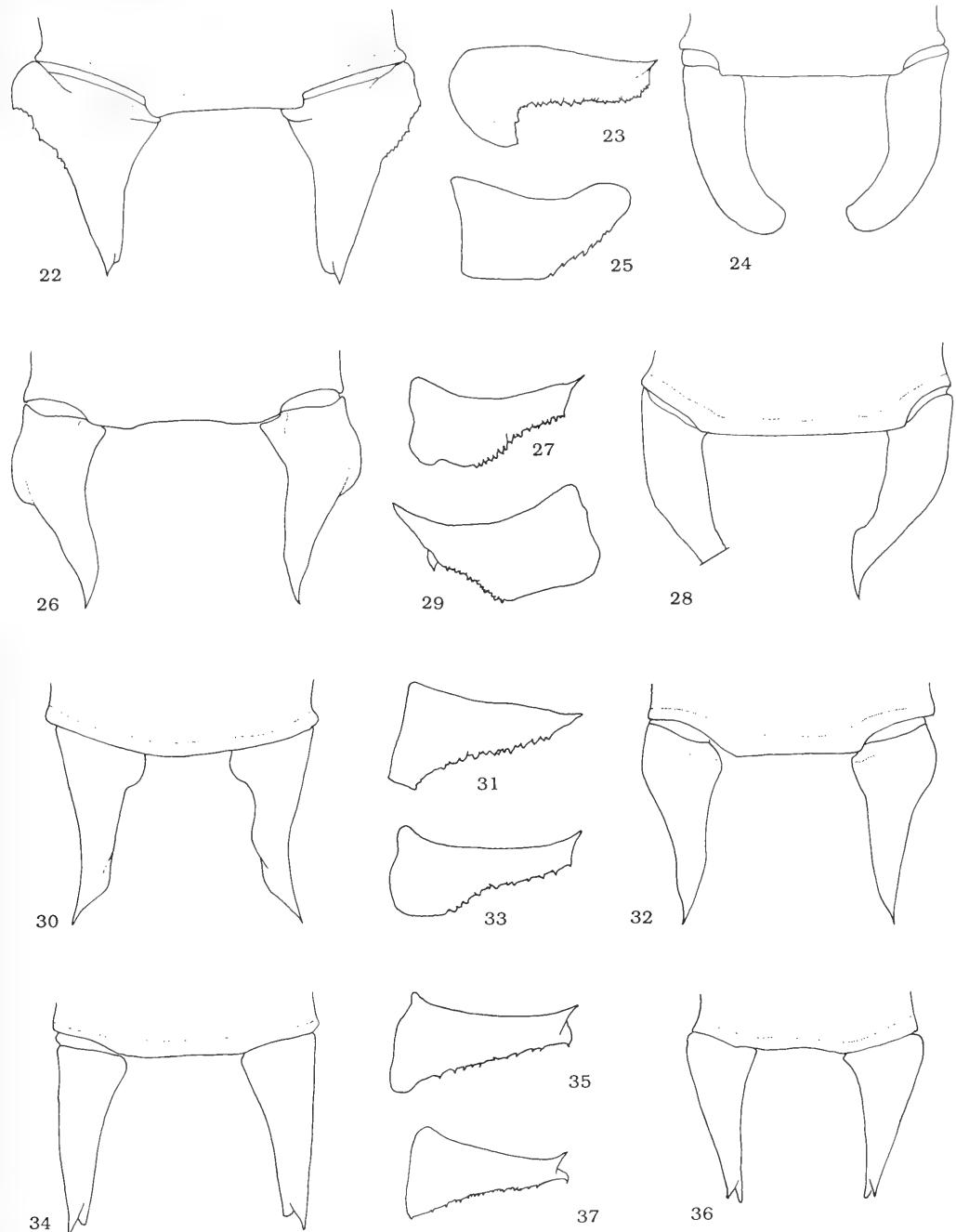
(8) Tubercles on occiput in female present (+) / absent (—)

(9) Tubercles on abdominal segment 10 of male present (+) / absent (—)



Figs. 15-21. – Thoracic pattern of left half of *Leptogomphus* species, dorsal view. – 15, *L. pendleburyi*, male holotype; 16, *L. cf. pasia*, male from Danum Valley; 17, *L. williamsoni*, female E. Borneo; 18, *L. coomansi*, male E. Borneo; 19, *L. lansbergei assimilis*, male S. Sumatra; 20, *L. gestroi*, male Thailand, Doi Suthap; 21, *L. inclitus*, female lectotype.

- Vertex black, without yellow or otherwise pale markings; transversal stripe on frons interrupted by a longitudinal black line in the middle (cf. figs. 8, 10, 11) 4
- 3. (2) Characteristic markings on thorax with very short dorsal stripe and large mesothoracic half collar (fig. 17). Occiput black. Postclypeus with latero-anterior corners pale coloured. Distribution: Borneo. *L. williamsoni* Laidlaw
- Markings on dorsal side of thorax less characteristic, with a mesothoracic half collar as in most other congeneric species and a complete dorsal stripe, which is not connected with the mesothoracic half collar (fig. 20). Occiput with a pale centre. Postclypeus brown, without pale markings. Superior appendages of male, figs. 22-23. Distribution: Thailand, Burma. *L. gestroi* Selys
- Note. Redescription of male and female with illustrations in Liefertink (1960: 238-240, fig. 6).
- 4. (2) Males 5
- Note. The male of *L. inclitus* (distribution Thailand) is unknown. See fig. 21 for the thoracic markings of the female. In all other species these markings agree well between male and female.
- Females 7
- 5. (4) Tip of superior appendage sharp with subterminally a blunt ventral tubercle, thus in lateral view bifid in appearance (figs. 34-35). Distribution: Philippine Islands. *L. semperi* (Selys)
- Tip of superior appendage sharp, but without subterminal ventral tubercle 6
- 6. (5) Dorsal stripe (nearly) connected with mesothoracic half collar (fig. 5, 16); head pattern as in fig. 8; superior appendages of male as in figs. 32-33. Distribution: Borneo. *L. cf. pasia* spec. nov.
- Dorsal stripe and mesothoracic half collar separated by a narrow black line; head pattern as in fig. 10; superior appendages of male as in figs. 30-31. Distribution: Java and Sumatra. *L. lansbergei* (Selys)
- Note. Specimens from Java belong to subspecies *lansbergei* and specimens from Sumatra to subspecies *assimilis*. According to Ris (1927: 28-29) the superior appendages of both subspecies are different.
- 7. (4) Valvula vulvae extremely long, extending to the hind margin of segment 10 (figs. 3-4); occiput without tubercles (fig. 2); head pattern as in fig. 1. Distribution: northern Borneo. *L. pasia* spec. nov.



Figs. 22-37. - *Leptogomphus* superior appendages of male, for all species in dorsal and lateral view respectively. - 22-23, *L. gestroi* from Thailand, Doi Sutaph; 24-25, *L. risi* from Thailand, Nakhon Sithammarat province; 26-27, *L. coomansi* from E. Borneo; 28-29, *L. pendleburyi*, holotype from northern Borneo; 30-31, *L. lansbergei lansbergei* from W. Java; 32-33, *L. cf. pasia* from eastern Sabah, Danum Valley; 34-35, *L. semperi* from Basilan I.; 36-37, *L. palawanus* from C. Palawan.

- Valvulae vulvae much shorter, extending not further than the hind margin of segment 9 8
- 8. (7) Occiput with four slender spiny tubercles; dorsal stripe connected with mesothoracic half collar. Distribution: Philippine Islands. *L. semperi* (Selys)

Note. A female in the collection of the RMNH from Mindanao keys out here. I consider this specimen doubtfully conspecific with the male from Basilan I., which was compared with the type of *L. semperi* by M. A. Lieftinck (for a detailed description of the male specimen, see also Laidlaw 1936: 269).

- Occiput with ridges or smooth, but always without spiny tubercles; dorsal stripe and mesothoracic half collar separated by a narrow black line 9
- 9. (8) Hind margin of occiput nearly straight or with two roundish tubercles in the middle (size of tubercles showing much variation). Labrum black with a paired subrectangular pale spot (cf. fig. 10). Last abdominal segments, fig. 12. Distribution: Java and Sumatra. *L. lansbergei* (Selys)

Note. According to Lieftinck (1948, p. 245 and fig. 9) specimens from Java (subspecies *lansbergei*) tend to have more conspicuous tubercles than specimens from Sumatra (subspecies *assimilis* Krüger).

- Hind margin of occiput against both eyes with an erect squarish tubercle (fig. 14). Labrum pale (creamish yellow ?) with a narrow dark stripe along the anterior margin and a very narrow longitudinal dark line in the middle. Last abdominal segments, fig. 13. Distribution: Thailand. *L. inclitus* (Selys)
- 10. (1) Middle of postclypeus with a yellow patch; antehumeral stripe absent or reduced to a small spot in posterior part of synthorax above humeral suture (fig. 18). Superior appendages of male, figs. 26-27. Distribution: Borneo. *L. coomansi* Laidlaw
- Postclypeus black or brownish black, without yellow markings; antehumeral stripe reduced to a larger or smaller pale spot in posterior part of synthorax above humeral suture 11
- 11. (10) Yellow mark on frons a single transversal stripe (fig. 9); thoracic pattern, fig. 7; superior appendages of male, figs. 28-29. Distribution: Northern Borneo. *L. pendleburyi* Laidlaw

Note. Only known from male holotype.

- Transversal pale stripe on frons divided in the middle, or at least with distinct dark triangular emarginations in the middle 12
- 12. Males 13
- Note. The male of *L. mariae* is unknown.
- Females 14
- 13. Superior appendages in dorsal view curved in-

- wards, tip bluntly shaped (figs. 24-25). Distribution: Malaysia. *L. risi* Laidlaw
- Superior appendages in dorsal view straight, tip bifid (figs. 36-37). Distribution: Palawan. *L. palawanus* Asahina

Note. Specimens from Borneo that key out here, may belong to *L. mariae*, of which the male is undescribed. See Lieftinck (1948, p. 248) for an illustration of the thoracic pattern of the female.

- 14. Occiput smooth, without tubercles. Distribution: Malaya. *L. risi* Laidlaw
- Occiput with conspicuous tubercles (Borneo and Philippine islands) 15
- 15. Area behind lateral ocelli with a sharp tubercle, directed posteriorly. Distribution: Palawan. *L. palawanus* Asahina
- Area behind the lateral ocelli with a semicircular transversal rim divided into two parts by a central depression (Borneo) *L. mariae* Lieftinck

Note. This species is only known from the female holotype. In other species with tubercles on the occiput, these tubercles may be absent or broken at one or both sides of the head.

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REFERENCES

Asahina, S., 1968. Records and notes on Philippine Odonata. — Japanese Journal of Zoology 15 (4): 349-376, figs. 1-58 + plate 1-2.

Asahina, S., 1970. Burmese Odonata collected by Dr. Arthur Svihla with supplementary notes on Asiatic Cetriagrion species. — Japanese Journal of Zoology 16 (2): 99-126, figs. 1-68 + plate 1.

Asahina, S., 1986. A list of the Odonata recorded from Thailand, Part XIV. Gomphidae-2. — Tombo 29: 7-53, figs. 1-201.

Carle, F. L., 1986. The classification, phylogeny and biogeography of the Gomphidae (Anisoptera). I. Classification. — Odonatalogica 15 (3): 275-326, tables 1-2.

Fraser, F. C., 1927. Indian dragonflies. Part XXVI. — Journal of the Bombay Natural History Society 31(4): 882-889, figs. 1-3.

Fraser, F. C., 1934. Odonata. Volume 2. — The Fauna of British India including Ceylon and Burma: i-xxiii + 1-398, figs. 1-119 + plate 1-4.

Krüger, L., 1899. Die Odonaten von Sumatra. II. Theil. Familie Aeschnidae. — Stettiner entomologische Zeitschrift 59 (1898): 267-331, figs.

Laidlaw, F. F., 1912. List of the Odonata taken on an expedition to Mt. Batu Lawi together with descriptions of supposed new species. — Journal of the Straits Branch of the Royal Asiatic Society 63: 92-99, figs. 1-5.

Laidlaw, F. F., 1914. Contributions to a study of the dragonfly fauna of Borneo. – Part II. The Gomphinae and Chlorogomphinae. – Proceedings of the Zoological Society of London 1914: 51-63 + plate 1.

Laidlaw, F. F., 1922. A list of the dragonflies recorded from the Indian Empire with special reference to the collection of the Indian Museum. Part V. The subfamily Gomphinae. (with an appendix by F. C. Fraser). – Records of the Indian Museum 24 (3): 367-426, figs. 1-21 + 1.

Laidlaw, F. F., 1931. A synonymic list of dragonflies of the family Gomphidae (Odonata, Anisoptera) found in the Oriental region. – Transactions of the Entomological Society of London 78 (2): 171-197.

Laidlaw, F. F., 1933. Notes on Malaysian dragonflies (Odonata), with descriptions of new species. – Bulletin of the Raffles Museum, Singapore, Straits Settlements 7 (1932): 95-96, figs. 1-2b.

Laidlaw, F. F., 1934. A note of the dragonfly fauna (Odonata) of Mount Kinabalu and of some other mountain areas of Malaysia: with a description of some new or little known species. – Journal of the Federated Malay States Museums 17 (3): 549-561, figs. 1-4.

Laidlaw, F. F., 1936. On some examples of the genus *Leptogomphus* (Odon., Gomphidae). – Treubia 15 (3): 267-270, figs. 1-2.

Lieftinck, M. A., 1934. An annotated list of the Odonata of Java, with notes on their distribution, habits and life-history. – Treubia 14 (4): 377-462.

Lieftinck, M. A., 1935. A synopsis of the Odonata (Dragonflies) of Sumatra. – Miscellanea Zoologica Sumatrana 92/93: 1-23, figs. 1-2.

Lieftinck, M. A., 1948. Descriptions and records of Southeast Asiatic Odonata. – Treubia 19 (2): 221-278, figs. 1-19.

Lieftinck, M. A., 1954. Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. – Treubia 22 (supplement): i-xiii + 1-202.

Lieftinck, M. A., 1960. On the identity of some little known Southeast Asiatic Odonata in European museums described by E. de Selys Longchamps, with descriptions of new species. – Memorie della Società entomologica Italiana 38: 229-256, figs. 1-13.

Martin, R., 1904. Liste des Neuroptères de l'Indo-Chine. – Mission Pavie Indochine 3: 204-221.

Needham, J. G. & M. K. Gyger, 1937. The Odonata of the Philippines. – The Philippine Journal of Science 63 (1): 21-101, figs. 1-2 + plate 1-10.

Ris, F., 1927. Odonaten von Sumatra, gesammelt von Edward Jacobson. – Zoologische Mededeelingen 10 (1): 1-49, figs. 1-24.

Selys Longchamps, E. de, 1878. Quatrièmes additions au synopsis des Gomphines. – Bulletin de l'Académie royale de Belgique (2) 46: sep. 1-106.

Selys Longchamps, E. de, 1891. Viaggio di Leonardo Fea in Birmania e regioni vicini. XXXII. Odonates. – Annali del Museo Civico di Storia Naturale di Genova (serie 2a) 10: 433-518.

Williamson, E. B., 1907. The dragonflies (Odonata) of Burma and Lower Siam. – II. Subfamilies Cordulegastrinae, Chlorogomphinae, and Gomphinae. – Proceedings of the United States National Museum 33 (1571): 267-317, figs. 1-39.

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DIE FAMILIE MALACHIIDAE (COLEOPTERA) AUF SULAWESI

43. Beitrag zur Kenntnis der indo-malaiischen Fauna

Wittmer, W., 1990. Die Familie Malachiidae (Coleoptera) auf Sulawesi. 43. Beitrag zur Kenntnis der indo-malaiischen Fauna. – Tijdschrift voor Entomologie 133: 107-120, figs. 1-29. [ISSN 0040-7496]. Published 31 July 1990.

The species of the family Malachiidae occurring on Sulawesi are revised. Twenty-five species are enumerated, of which nineteen are described as new to science. The genus *Luzonotroglops* Pic, 1924 is synonymized with *Falsolaius* Pic, 1917, and the genus *Flabellapalochrus* Pic, 1923 with *Dromanthomorphus* Pic, 1921. *Carphurus tondanus* Champion, 1923 is synonymized with *C. rufonotaticeps* Pic, 1917.

Dr. W. Wittmer, Naturhistorisches Museum, CH-4001, Basel, Schweiz.

Key words. – Malachiidae, Sulawesi, new species.

EINLEITUNG

Von der Insel Sulawesi waren bisher nur 5 Arten der Familie Malachiidae beschrieben worden und zwar *Carphurus celebensis* Champion, *C. rufonotaticeps* Pic, *C. tondanus* Champion, *Laius ribbei* Pic und *Dromanthomorphus cyaneus* Pic. *Carphurus tondanus* musste eingezogen werden, weil diese Art Synonym mit *C. rufonotaticeps* ist. Zwei weitere Arten: *Carphurus cf. rubroannulatus* Motschulsky und *Laius cyaneus* Guérin haben eine weitere Verbreitung und werden heute zum ersten Mal von Sulawesi gemeldet. Weitere 19 Arten stellten sich als neu für die Wissenschaft heraus. Sie stammen von dem reichen Material, das ich Herrn Dr. Peter Hammond, London, verdanke, das im British Museum (Natural History) aufbewahrt wird und vom "Project Wallace", sponsored by the Royal Entomological Society of London and the Indonesian Institute of Science, Results of Project Wallace No. 85 aufgesammelt wurde.

Den Londoner Koleopterologen, den Herren M. J. D. Brendell, Dr. Peter Hammond, Dr. Christopher Lyal und Dr. Nigel Stork, die auf Sulawesi so erfolgreich tätig gewesen sind, gratuliere ich für die schönen dort erzielten Resultate.

Des weiteren danke ich Herrn G. Hodebert, Paris, für die sorgfältig ausgeführten Zeichnungen und Herrn Dr. Ch. O'Toole, Hope Museum, Oxford, für die ausgeliehenen Typen.

Verwendete Abkürzungen: BM = British Museum (Natural History), London; MP = Muséum de Paris; NHMB = Naturhistorisches Museum, Basel.

SYSTEMATISCHER TEIL

Bestimmungstabelle für die auf Sulawesi vorkommenden Gattungen

1. Die Flügeldecken bedecken das Abdomen vollkommen. Fühler anscheinend 10-gliedrig, das Glied 2 steckt ganz im 1. Vordertarsen einfach, oder das Tarsenglied 2 ist mit einem Kamm versehen 2
- Die Flügeldecken sind verkürzt und lassen mehrere Tergite unbedeckt. Fühler 11-gliedrig, das Glied 2 ist voll sichtbar. Glied 1 der Vordertarsen mit einem Kamm (Carphurinae) 3
2. Fühlerglied 3 difform, meist mehr oder weniger stark ausgehöhlten. Vordertarsen ohne Kamm *Laius* Guérin
- Fühler von Glied 3 an gekämmt. Glied 2 der Vordertarsen mit Kamm *Dromanthomorphus* Pic
3. Flügeldecken einfach, ohne Auszeichnungen 4
- Flügeldecken gegen die Spitze mit einer mehr oder weniger deutlichen Grube oder Eindruck, mit vermehrten Haaren am Rand *Paracarphurus* Wittmer
4. Halsschild gegen die Basis schwach bis stark verengt bis eingeschnürt, vor dem Basalrand mässig bis stark quer eingedrückt. Fühler und Körper normal behaart 5
- Halsschild vor der Basis schwach gerundet verengt, Seiten davor fast parallel, ohne queren Eindruck vor dem Basalrand. Körper und besonders die Fühler, meistens auch die Beine

sehr lang behaart *Telocarphurus* Wittmer
 5. Halsschild gegen die Basis schwach verengt, vorderer Teil der Scheibe wenig bis kaum aufgewölbt, Eindruck vor dem Basalrand nur schwach entwickelt. Rippen auf den Flügeldecken fehlen immer *Carphurus* Erichson
 — Halsschild gegen die Basis stark eingeschnürt, vorderer Teil der Scheibe stark gerundet aufgewölbt, Eindruck vor dem Basalrand breit. Rippen auf den Flügeldecken fast immer vorhanden *Falsolaius* Pic

Carphurus Erichson, 1840**Bestimmungstabelle für die auf Sulawesi vorkommenden Arten**

1. Halsschild mit mehr oder weniger feinen Querrunzeln auf der Scheibe und an den Seiten 2
- Halsschild ohne Querrunzeln auf der Scheibe, diese meistens glatt, schwach matt, oder punktiert 8
2. Halsschild und Flügeldecken schwarz, letztere manchmal mit einer mehr oder weniger grossen und deutlichen hellen (weisslichen) Aufhellung, oder vorwiegend weisslich 3
- Halsschild und Flügeldecken gelb oder hellbraun 7
3. Flügeldecken einfarbig schwarz, oder mit mehr oder weniger grossen und deutlichen hellen (weisslichen) meistens seitlich gelegenen Aufhellungen, Naht immer dunkel 4
- Flügeldecken fast ganz weisslich, nur an der Basis schmal angedunkelt, Seiten und Spitzen manchmal, jedoch noch schmäler als an der Basis, angedunkelt *C. albipennis* sp.n.
4. Fühler kürzer, letzte 4 bis 8 Glieder angedunkelt bis schwarz 5
- Fühler länger (Abb. 2) einfarbig gelb, nur die Spitze des letzten Gliedes ist dunkel *C. pallidicornis* sp.n.
5. Vorderschienen dunkel bis schwarz. Flügeldecken glänzender, manchmal mit leichtem violettem Schimmer, Punktierung etwas tiefer, Haare schwarz 6
- Vorderschienen gelb. Flügeldecken weniger glänzend, manchmal leicht matt, ohne Metallschimmer, Punkte etwas weniger tief, Haare greis *C. dumogaensis* sp.n.
6. Grössere Art: 6 mm (♀). Fühler (Abb. 6) sehr stark gezahnt (♀). Flügeldecken schwarz mit schwachem violettem Schimmer *C. celebensis* Champion
- Kleinere Art: 4-5 mm (♀). Fühler weniger stark gezahnt (♀). Flügeldecken schwarz, ohne Metallschimmer oder heller (weisslicher) Auf-

hellung *C. strigilatus* sp.n.
 7. Der ganze Körper ist einfarbig gelb. Fühler (Abb. 7) länger, alle Glieder länger als breit, schwach gezahnt (♂), einfarbig gelb oder die letzten 1 bis 5 Glieder angedunkelt, selten ist die Mittel- und Hinterbrust dunkel *C. totopallidus* sp.n.
 — Nur die Oberseite ist einfarbig gelb, auf der Unterseite ist die Vorder- und Mittelbrust, meistens auch die Hinterbrust schwarz, manchmal auch das Abdomen, Basis der Mittel- und Hinterschenkel, seltener der Vorderschenkel dunkel. Fühler (Abb. 9) kürzer, einzelne Glieder so lang wie breit oder breiter als lang (♂), einfarbig gelb oder ein paar der letzten Glieder sind leicht angedunkelt *C. partepallidus* sp.n.
 8. Halsschild einfarbig rot oder orange bis gelb 9
 — Halsschild einfarbig schwarz oder zum grössten Teil schwarz 10
 9. Grosse Art: 5-6 mm. Halsschild rot, glatt, in den Vorderecken befinden sich ein paar grobe Punkte. Flügeldecken schwarz *C. cf. rubroannulatus* Motschulsky
 — Kleine Art: 2,5-3 mm. Halsschild orange bis gelb, fein chagriniert, leicht matt. Flügeldecken gelblich, basale Hälfte bis ein Drittel dunkel *C. basilimbatus* sp.n.
 10. Halsschild einfarbig schwarz 11
 — Halsschild an der Basis schmal gelblich gesäumt *C. testaceolimbatus* sp.n.
 11. Kopf einfarbig schwarz 12
 — Kopf rot, an den Schläfen und manchmal an der Stirnbasis schmal schwarz. Flügeldecken schwarz mit einem weisslichen mehr oder weniger ausgeprägten Längswisch *C. brendelli* sp.n.
 12. Kopf zum grössten Teil glatt, vereinzelt mit feinen Punkten besetzt. Halsschild ohne Punkte an den Seiten 13
 — Kopf mit ausgesprochen tiefen und groben Punkten besetzt, besonders an der Basis, Zwischenräume glatt. Halsschild an den Seiten punktiert, Punkte an der Basis ineinander fliessend *C. rufonotaticeps* Pic
 13. Kopf so breit wie der Halsschild, dieser mit feinen Querrunzeln basal an den Seiten des Quereindrucks. Punktierung der Flügeldecken wenig deutlich, fast erloschen *C. storki* sp.n.
 — Kopf deutlich breiter als der Halsschild, dieser ohne feine Querrunzeln basal an den Seiten des Quereindrucks. Punktierung der Flügeldecken deutlich grob *C. lyali* sp.n.

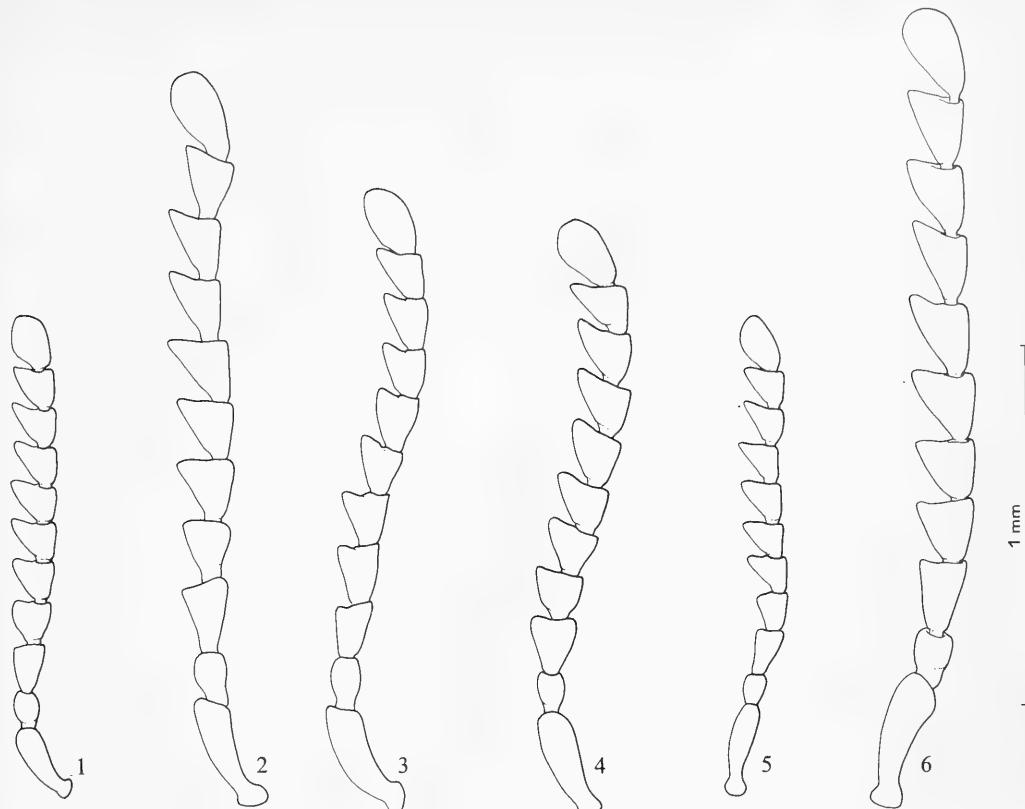


Abb. 1-6. Fühler von *Carphurus*. — 1, *C. albipennis* sp.n. ♂; 2-3, *C. pallidicornis* sp.n. (2, ♂. 3, ♀); 4-5, *C. dumogaensis* sp.n. (4, ♂. 5, ♀); 6, *C. celebensis* Champion ♀.

Carphurus albipennis sp.n. (Abb. 1)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., lowland forest, ca. 200 m, 11.vii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, ii, vi, vii, x, xi und xii.1985 (14 BM, 12 NHMB); Fog 13, trays 81, 105, 106 (Plot A), 230/240 m, 11.vii.1985, (2 BM, 1 NHMB).

♂. Kopf einfarbig schwarz, von der Mitte nach vorne manchmal teilweise leicht, selten ganz aufgehellt; Maxillarpalpen gelb; Fühler gelb, die letzten 3 bis 5 Glieder mehr oder weniger dunkel; Halsschild, Schildchen und Abdomen schwarz; Flügeldecken weisslich, ringsum schmal, schwach angedunkelt, manchmal nur angedeutet; Schenkel nur an der Basis oder fast bis zu den Knien schwarz bis dunkel, Schienen gelb oder ein wenig angedunkelt, Tarsen gewöhnlich gelb, selten schwach angedunkelt.

Kopf mit den Augen breiter als der Halsschild, Stirne leicht gewölbt, Querrunzeln an der Stirnbasis nur angedeutet, restliche Oberfläche fast glatt, zerstreute Haarpunkte sichtbar. Fühler (Abb. 1) die

Schultern ein wenig überragend, Glieder 4 bis 10 schwach stumpf gezahnt, einzelne Glieder ein wenig breiter als lang, 3 zur Spitze verbreitert. Halsschild kaum merklich breiter als lang, Seiten gerundet, gegen die Basis ein wenig stärker verengt als nach vorne, Scheibe regelmässig gewölbt, vor der Basis nicht quer eingedrückt und abgesetzt, Oberfläche dicht mit feinen Querrunzeln bedeckt. Flügeldecken nach hinten etwas erweitert, 3 bis 4 Tergite unbedeckt lassend, fast glatt, zerstreut mit ziemlich grossen, ganz flachen Haarpunkten besetzt. Behaarung des ganzen Körpers fein und greis, nur auf dem Kopfe und Halsschild ein paar gröbere, dunkle, längere Haare.

Länge: Knapp 3 mm.

Neben *C. dumogaensis* Wittmer zu stellen, der nachfolgend beschrieben wird.

Carphurus pallidicornis sp.n. (Abb. 2-3)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Gng. Ambang F.R., near Kotamobagu, Gng. Muajat summit area, ca. 1780 m, 30.v.-2.vi.1985 (BM). Paratypen:

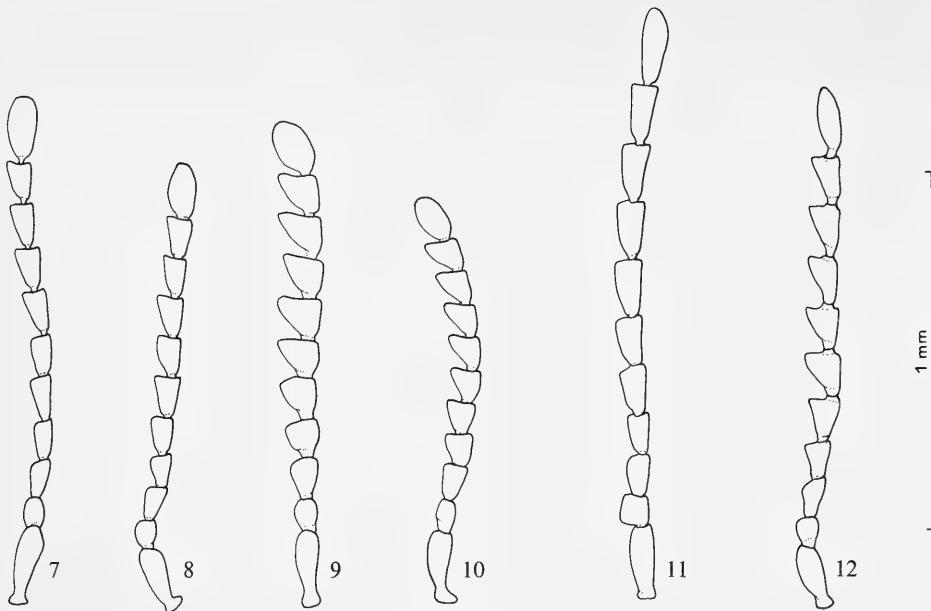


Abb. 7-12. Fühler von *Carphurus*. — 7-8, *C. totopallidus* sp.n. (7, ♂. 8, ♀); 9-10, *C. partepallidus* sp.n. (9, ♂. 10, ♀); 11, *C. basilimbatus* sp.n. ♂; 12, *C. testaceolimbatus* sp.n. ♂.

Gleicher Fundort wie Holotypus, iv und xi.1985 (1 BM, 1 NHMB); Clarke Camp, lower montane forest, 1140 m, x.1985 (1 BM, 1 NHMB); Sulawesi Tengah: Mt. Tambusisi, 6500', 01°38'S-121°23'E, 8-9.iv.1980, M. J. D. Bredell (1 BM, 2 NHMB).

Kopf selten einfarbig schwarz und einer kleinen, schlecht begrenzten hellen Makel zwischen den Augen, oder der ganze Vorderkopf bis hinter die Fühlerwurzeln ist orangebraun; Fühler gelb, nur die Spitze des letzten Gliedes ist mehr oder weniger breit schwarz; Halsschild, Schildchen, Flügeldecken und Unterseite schwarz, nur bei 1 Exemplar ist das zweit- und drittletzte Tergit ein wenig aufgehellt; alle Tibien und Tarsen gelb, bei den Mittel- und Hintertibien manchmal ein wenig angedunkelt, Schenkel schwarz, an der Spitze mehr oder weniger breit gelb, bei den vorderen am breitesten gelb.

♂. Kopf mit den stark vorstehenden Augen breiter als der Halsschild, Stirne leicht gewölbt, einige Querrunzeln an der Basis, davor grob punktiert, nur in der Mitte eine kleinere fast punktfreie Stelle. Fühler (Abb. 2) ziemlich lang, ca. 2½ mal so lang wie der Halsschild, von Glied 3 an gezahnt, 3 ein wenig länger als die folgenden. Halsschild kaum merklich breiter als lang (22×21), Seiten kaum gerundet, gegen die Basis ein wenig verengt, Scheibe regelmäßig gewölbt, vor der Basis nur ganz schwach eingedrückt, Oberfläche dicht mit Querrunzeln bedeckt. Flügeldecken nach hinten leicht erweitert, 2½ bis 3 Tergite unbedeckt lassend, Oberfläche ziemlich dicht mit feinen manchmal etwas erloschenen Punkten besetzt, Behaarung ziemlich

dicht, dunkel.

♀. Die Fühler (Abb. 3) sind kürzer als beim ♂, weniger stark gezahnt, sonst mit dem ♂ übereinstimmend.

Länge: 4-5 mm.

Ein wenig grösser als *C. dumogaensis* Wittmer, mit diesem nahe verwandt, zu unterscheiden durch die längeren, stärker gezahnten Fühler, die fast einfarbig gelb sind, ausgenommen die Spitze von Glied 11 und die durchwegs gelben Vorderschienen und Tarsen.

Carphurus dumogaensis sp. n. (Abb. 4-5)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., G. Mogogonipa summit, 1008 m, v.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, v. und xi.1985 (15 BM, 12 NHMB); Clarke Camp, lower montane forest, 1140 m, iv, v und x.1985 (4 BM, 5 NHMB).

Schwarz bis schwarzbraun, Kopf auf der vorderen Hälfte meistens mehr oder weniger rötlich bis gelblich aufgehellt; Fühler gelb, die letzten paar Glieder ein wenig angedunkelt oder ganz dunkel; die letzten Tergite manchmal gelblich; Schenkel meistens schwarz, oder an den Knien kurz gelb, Tibien ein wenig aufgehellt, die vorderen meistens ganz gelb, Tarsen gelb bis braun.

♂. Kopf mit den Augen deutlich breiter als der Halsschild, Stirne leicht gewölbt, Stirnbasis mit ein paar deutlichen Querrunzeln, davor und neben den

Augen ziemlich grobe Punkte, die gegen die Mitte und nach vorne rasch feiner werden. Fühler (Abb. 4) ungefähr so lang wie die Flügeldecken, Glieder 4 bis 10 ziemlich scharf gezahnt, 3 gegen die Spitze verbreitert. Halsschild kaum merklich breiter als lang, Seiten gerundet, gegen die Basis ein wenig stärker verengt als nach vorne, Scheibe regelmässig gewölbt, vor der Basis nicht quer eingedrückt und abgesetzt, Oberfläche dicht mit Querrunzeln bedeckt. Flügeldecken nach hinten leicht erweitert, 4 Tergite unbedeckt lassend, Oberfläche ziemlich dicht mit feinen, etwas erloschenen Punkten besetzt, leicht matt wirkend. Behaarung wie bei *C. albipennis* Wittmer.

♀. Fühler (Abb. 5) ein wenig kürzer und weniger breit gezahnt.

Länge: 3-3.8 mm.

Eine mit *C. albipennis* Wittmer nahe verwandte Art, die sich durch etwas grössere Gestalt und die dunklen, etwas stärker punktierten Flügeldecken unterscheidet. Der Kopf ist bei *dumogaensis* im Durchschnitt um ca. 15% breiter als der Halsschild und misst im Ø 0.8 mm, bei *albipennis* ist er nur ca. 8-9% breiter als der Halsschild und misst im Ø 0.7 mm.

Carphurus celebensis Champion (Abb. 6)

Carphurus celebensis Champion, 1923: 12.

Die Art wurde nach 1 ♀ aus Tondano, Celebes beschrieben, der Holotypus befindet sich im Hope Museum Oxford, ex Wallace. In dem vorliegenden Material ist *C. celebensis* nicht vertreten. Die Art ist grösser als alle anderen auf Sulawesi vorkommenden Arten mit quergerunzeltem Halsschild. Für die Abb. 6 des Fühlers diente der Holotypus. Der Fühler erinnert im Bau und in der Grösse an *C. pallidicornis* sp.n. ♂, doch ist er bei *celebensis* schwarz, nur die ersten Glieder sind hauptsächlich auf der Unterseite aufgehellt. Der Kopf und Halsschild besitzen einen schwachen grünlichblauen und die Flügeldecken einen blauvioletten Schimmer.

Carphurus strigilatus sp.n.

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., lowland forest, ca. 200/300 m, viii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, ii, iv, vi und viii.1985 (16 BM, 12 NHMB); idem lowland forest, ca. 200 m, i, ii, iii, iv, v, vi, vii und viii.1985 (24 BM, 14 NHMB); idem near Edward's Camp, ca. 500 m, iv und x.1985 (5 BM); idem Fog 9, Tray 46, mixed crops, 1.iii.1985 (1 BM); idem Hog's Back Camp, lowland forest, 492 m, vii.1985 (1 BM).

Kopf vorwiegend schwarz, vorderer Teil bis über die Fühlerwurzeln rötlichbraun, manchmal erstreckt sich die helle Färbung bis zwischen die Au-

gen; Fühler schwärzlich, erste 3 bis 5 Glieder gelblich; Halsschild und Schildchen schwarz; Flügeldecken einfarbig schwarz oder schwärzlich, oder jede Decke mit einer hellen Längsaufhellung, mehr oder weniger deutlich, meistens mehr an den Seiten gelegen, ohne sie zu berühren; Unterseite schwarz, letzte 1 bis 3 Segmente oft gelbraun; Beine schwarz, oft sind die Tarsen, meistens nur die vorderen, aufgehellt.

Die übrigen Merkmale inklusive die Fühler stimmen mit der Beschreibung von *C. dumogaensis* überein, bis auf die Flügeldecken, die glänzender sind mit gröberer Punktierung, Behaarung etwas kräftiger, schwarz.

Länge: 4-4.3 mm.

Diese Art ist nahe mit *C. dumogaensis* Wittmer verwandt, sie unterscheidet sich durch etwas grössere Gestalt, die dunklen Beine bei denen höchstens die Vordertarsen gelblich sind, selten sind die Vorderschenkel an den Knien und die Vordertibien an der Spitze kurz aufgehellt. Die Flügeldecken sind von variabler Färbung, bei *dumogaensis* immer dunkel, sie glänzen, haben tiefere Punkte und die Behaarung ist kräftiger, dunkel, bei *dumogaensis* greis.

Carphurus totopallidus sp.n. (Abb. 7-8)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., lowland forest, ca. 200/300 m, viii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, ii, iii, iv, vii, viii, x, xi und xii.1985 (13 BM, 8 NHMB); idem Fog 1, trays 2, 5, 12, 87 (Plot A), 230 m, 5.ii.1985 (3 BM, 1 NHMB); idem Fog 3, trays 6, 43, 47, 54, 55, 67, 85, 88, 95 (Plot B), 315 m, 8.ii.1985 (9 BM, 2 NHMB); idem Fog 5, trays 8, 10, 17, 24, 27, 30, 31, 41, 43, 46, 47, 52, 54, 72, 91, 101, 106 (Plot C), 400 m, 11.ii.1985 (21 BM, 2 NHMB); idem Fog 11, trays 23, 24, 36, 41, 43, 52, 60, 65, 67, 69, 71, 72, 74, 76, 82, 89, 93, 94, 95, 96 (Plot A), 230 m, 10.iii.1985 (22 BM, 3 NHMB); idem Fog 13, trays 4, 9, 11, 12, 14, 22, 25, 26, 30, 34, 41, 50, 54, 68, 78, 79, 85, 86, 87, 88, 90, 93, 98, 99, 100, 103 (Plot A) (21 BM, 6 NHMB); idem Fog 15, trays 44, 60, 91 (Plot C) (3 BM); idem Fog 26, trays 27, 74, 76, 77, 86, 102, 107, 112 (Plot A) (10 BM).

Einfarbig blossgelb, ausgenommen die Fühler, bei denen die Glieder 5 oder 6 bis 11 dunkel sind, seltener 8 bis 11, oder nur 11, selten sind die Fühler einfarbig gelb; manchmal ist die Unterseite angedunkelt.

♂. Kopf mit den Augen breiter als der Halsschild, fast so breit wie die Flügeldecken an den Schultern, Stirne leicht gewölbt, Querrunzeln an der Stirnbasisc wenig ausgeprägt, davor wenige Punkte, die gegen die Mitte der Augen erloschen, von hier ab fast glatt. Fühler (Abb. 7) ungefähr so lang wie die Flügeldecken, Glieder länger als breit, gegen die Spitze leicht verbreitert, 5 bis 10 unter sich ungefähr gleich lang. Halsschild ungefähr so lang wie

breit, Seiten gerundet, gegen die Basis kurz verengt, Scheibe gewölbt, vor der Basis leicht quer eingedrückt, dieser Teil ein wenig aufgewölbt; Oberfläche mit feinen Querrunzeln die von der Basis bis kurz über die Mitte oder noch weiter nach vorne sichtbar sind. Flügeldecken nach hinten leicht verbreitert, ein wenig klaffend, ca. 3 Tergite unbedeckt lassend, Oberfläche bei einzelnen Individuen fast glatt, höchstens Haarpunkte sichtbar, bei anderen mit deutlicher, etwas erloschener Punktierung, Behaarung sehr fein, hell.

♀. Eigentlich nur durch das Fehlen des Kammes am Glied 1 der Vordertarsen vom ♂ verschieden, denn die Fühler (Abb. 8) zeigen wenig Unterschiede, sie sind kaum merklich kürzer.

Länge: 2-3 mm, mit dem Abdomen, das bei den ♀ oft stark vorsteht.

Neben *C. testaceipennis* Pic zu stellen, der jedoch einen glatten, an der Basis ein wenig stärker eingedrückten Halsschild besitzt. Die Fühlerglieder sind bei *testaceipennis* zur Spitze weniger verbreitert.

Carphurus partepallidus sp.n. (Abb. 9-10)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., lowland forest, malaise trap, ca. 200 m, ii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, ii, iii, vi, ix, x und xi.1985 (78 BM, 29 NHMB); idem Fog 13, trays 77, 82, 100 (Plot), 11.vii.1985 (3 BM); idem Edward's Camp, lowland forest, malaise trap, ca. 664 m, 26.iv-28.v.1985, 1-16.x.1985 (2 BM); Sulawesi Tengah: near Morowali, Ranu River area, ii und iii.1985 (3 BM).

Kopf, Halsschild und Schildchen orange; Fühler gelborange, letzte 1 bis 5 Glieder mehr oder weniger angedunkelt, selten einfarbig gelborange; Flügeldecken gelb; Mittel- und Hinterbrust dunkel, Coxen, Trochanteren und Hinterschenkel manchmal bis über die Mitte dunkel, Mittelschenkel an der Basis oft kurz dunkel, Vorderschenkel meistens einfarbig gelb, Tibien und Tarsen gelb; Hinterleib stellweise oft leicht angedunkelt, Rest gelblich, seltener ganz dunkel.

♂. Kopf mit den Augen breiter als der Halsschild, Stirne leicht gewölbt, Querrunzeln an der Stirnbasis kaum erkennbar, diese Stelle ist mit mehreren Punkten besetzt, die an den Seiten zahlreicher sind und bis zu dem Hinterrand der Augen und nach vorne bis zu den Fühlerwurzeln reichen, zwischen den Augen fast glatt. Fühler (Abb. 9) verhältnismässig kurz und kräftig, nicht ganz $2\frac{1}{2}$ mal so lang wie der Halsschild, breit gezahnt, einzelne Glieder ein wenig breiter als lang, 3 länger als 4. Halsschild ein wenig breiter als lang (18×16), Seiten gerundet, gegen die Basis ein wenig stärker verengt als nach vorne; Oberfläche mit deutlichen Querrunzeln; Scheibe gewölbt, an der Basis kaum angedeutet eingedrückt. Flügeldecken nach hinten leicht verbreitert, ca. 3 bis 4 Tergite unbedeckt lassend, Punkte deutlich, etwas erloschen, ihr Abstand viel grösser als ihr Durchmesser, Behaarung sehr fein, weisslich.

♀. Fühler (Abb. 10) ein wenig kürzer, weniger breit gezahnt, sonstiger Bau und Skulptur wie beim ♂.

Länge: ca. 3 mm.

Diese Art gehört in die Verwandtschaft von *C. albipennis* Wittmer, sie unterscheidet sich hauptsächlich durch die Färbung, vergleiche Beschreibung und Bestimmungstabelle.

Carphurus cf. rubroannulatus Motschulsky

Carphurus rubroannulatus Motschulsky, 1859: 64.

Material. — Indonesia, Sulawesi Utara: Dumoga Bone N.P., lowland forest edge, ca. 200 m, malaise trap, ii und iii.1985 (1 BM, 1 NHMB); Sulawesi Tengah: near Morowali, Ranu River area, iii.1980, at light, M. J. D. Brendell (1 BM, 1 NHMB).

Diese Art ist von Ceylon beschrieben und von Indien, Tenasserim, Siam, Penang, Singapore, Java, Sarawak, Laos, Tonkin, Philippinen, Palawan, Sumatra, Molukken, Ceram, Buru, Borneo in der Literatur erwähnt. Aehnliche Arten sind aus Sumatra (*C. atramaculatus* Pic), Burma (*C. birmanicus* Pic) beschrieben. Aus Sulawesi liegen mir 4 ♀ vor, die ich aufgrund ihrer Aehnlichkeit provisorisch als *rubroannulatus* bestimme.

Carphurus basilimbatus sp.n. (Abb. 11)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Hog's Camp, lowland forest, 492 m, vii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, vii.1985 (1 NHMB); idem Fog 5, trays 1, 5, 46, 49, 52, 69, 70, 88, 100 (Plot C), 400 m, 11.ii.1985 (6 BM, 3 NHMB); idem Fog 15, trays 81, 105, 106 (Plot C), 19.vii.1985 (2 BM, 1 NHMB); idem sites 10 and 11, Tumpah Transect, 664 m, 19-25.ii.1985 (1 BM).

Kopf und Halsschild einfarbig gelborange; Fühler gelblich, letzte 3 bis 5 Glieder etwas angedunkelt; Schildchen und grösster Teil der Unterseite mehr oder weniger aufgehellt; Flügeldecken gelblich, Basis zu $\frac{1}{2}$ bis $\frac{2}{3}$ schwarz; Beine blassgelb.

♂. Kopf mit den Augen breiter als der Halsschild, Stirne leicht gewölbt, Stirne schmal, gegen den Hinterrand der Augen breiter, ziemlich dicht punktiert, zwischen den Augen glatt, hier stehen nur ganz vereinzelte Punkte. Fühler (Abb. 11) ziemlich lang, wenig mehr als 3 mal länger als der Halsschild, Glieder länglich, gegen die Spitze etwas verbreitert, 2 breiter als 3, ein wenig nach unten verlängert. Halsschild nur wenig breiter als lang (16×15), Seiten gerundet, kurz vor der Basis ein wenig verengt, Scheibe schwach gewölbt, vor der

basis schwach eingedrückt; Oberfläche fein punktiert, stellenweise ein wenig gewirkt, dadurch leicht matt wirkend. Flügeldecken nach hinten leicht erweitert, ca. 3 bis 4 Tergite unbedeckt lassend, fast unpunktiert, leicht gewirkt, Behaarung fein, greis. Letztes Tergit sehr kurz, breiter als lang.

♀. Die Fühler sind kaum merklich kürzer als beim ♂, Glied 2 ebenfalls nach unten verbreitert.

Länge: 2.5-3 mm.

Eine durch die Färbung der Flügeldecken sehr charakteristische Art, dem *C. semiflavus* Wittmer sehr ähnlich und die ausserdem durch das verdickte Fühlerglied 2 auffällig ist, das bei *semiflavus* nicht verdickt ist.

Carphurus testaceolimbatus sp.n.

(Abb. 12)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Fog 3, tray 5 (Plot B), 315 m, 8.ii.1985 (BM). Paratypen: idem Fog 12, tray 29 (Plot A), 280 m, 5.v.1985 (1 BM); idem Fog 26, tray 89 (Plot A), 230 m, 2.xii.1985 (1 NHMB).

♂. Kopf, Schildchen und Abdomen schwarzbraun; Fühler schwarz, erste 4 bis 5 Glieder gelb; Halsschild schwarzbraun, basales Drittel bis Viertel gelbbraun; Flügeldecken schwarzbraun, mit einem gelblichweissen Querband vor der Mitte, ungefähr so breit wie der Abstand zur Basis; Beine gelblich.

Kopf mit den Augen breiter als der Halsschild, Stirne ziemlich flach, Schläfen runzlig gewirkt oder mit Querrunzeln, die manchmal bis zur Stirnbasis zu erkennen sind, Rest des Kopfes glatt mit ganz vereinzelten Punkten. Fühler (Abb. 12) 3.5 mal so lang wie der Halsschild, Glieder 3 bis 10 gezahnt, unter sich ungefähr gleich lang. Halsschild ungefähr so lang wie breit, Seiten leicht gerundet, von der Mitte zur Basis stärker verengt als nach vorne; Scheibe gewölbt, vor dem Basalrand flach, jedoch praktisch nicht eingedrückt; Oberfläche glatt, glänzend, wie der Kopf punktiert. Flügeldecken fast parallel, ca. 4 Tergite unbedeckt lassend, glatt glänzend, ein paar Haarpunkte kaum sichtbar, Behaarung spärlich, schräg aufstehende kleine Borsten, ausserdem 3 bis 4 längere Borsten auf jeder Decke.

Länge: 2.2-3 mm.

Deise Art unterscheidet sich von *C. lyali* sp.n. durch den mit einem gelblichen Saum versehenen Halsschild und dem gelblichweissen Querband auf den Flügeldecken; die Fühler sind bei *testaceolimbatus* ein wenig stärker gezahnt, die Flügeldecken praktisch glatt, bei *C. lyali* sp.n. deutlich punktiert.

Carphurus brendelli sp.n.

(Abb. 13-14)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Fog 11, tray 24 (Plot A), 10.iii.1985

(BM). Paratypen: idem Fog 12, tray 112 (Plot A), 5.v.1985 (1 BM); idem Toraut alluv. forest, 1-2.ii.1985 (1 NHMB); idem Plot A, ca. 200 m, lowland forest, 6-13.iii.1985 (1 BM); idem Edward's Camp, lowland forest, 664 m, 26.iv.1985 und x.1985 (1 BM, 1 NHMB).

Kopf rot, Wangen und manchmal die Kopfbasis schmal schwarz; Fühler schwarz, erste 4 bis 5 Glieder gelb; Halsschild, Schildchen, Unterseite und Flügeldecken schwarz, letztere mit einem verschwommenen bis deutlichen, weisslichen, mehr oder weniger langen Längsflecken, der weder die Naht noch die Seiten berührt; Beine gelb, beim einzigen vorliegenden ♂ sind die Hinterschenkel fast bis zu den Knien schwarz, die Hintertibien angehaucht dunkel; bei den ♀ sind oft auch die Mittelschenkel fast bis oben, seltener die Vorderschenkel an der Basis kurz schwarz.

♂. Kopf mit den Augen ein wenig breiter als der Halsschild, Stirne leicht gewölbt, Schläfen an der Basis mit Querrunzeln, an der Stirnbasis meistens durch den Halsschildvorderrand verdeckt, davor wenige gröbere Punkte, Rest des Kopfes praktisch glatt. Fühler (Abb. 13) sehr lang, 4 mal so lang wie der Halsschild, Glieder 5 bis 10 zur Spitze regelmässig leicht verbreitert, 4 ein wenig länger als 5, zur Spitze stärker verbreitert als dieses, breit ausgerandet, 3 ein wenig kürzer als 4, 2 nach unten leicht gerundet erweitert, fast so breit wie 1. Halsschild ein wenig länger als breit (24×22), Seiten nur schwach gerundet, gegen die Basis verengt; Scheibe in der Mitte ein wenig stärker gewölbt, vor dem Basalrand deutlich quer eingedrückt; Oberfläche glatt, ein paar Haarpunkte sichtbar. Flügeldecken nach hinten leicht erweitert, ca. 5 Tergite unbedeckt lassend, Punktierung spärlich, fast erloschen. Glied 1 der Vordertarsen verlängert und mit einem langen, an der Spitze gerundeten Kamm versehen.

♀. Fühler (Abb. 14) einfach, wesentlich kürzer als beim ♂.

Länge: 3.5-4.5 mm.

Färbung und Körperform wie bei *C. rouyeri* Pic, verschieden durch den Bau des Fühlers beim ♂, dessen Glied 4 breit ausgerandet ist.

Carphurus rufonotaticeps Pic

Carphurus rufonotaticeps Pic, 1917: 9.

Carphurus tondanus Champion, 1923: 35, syn.n.

Material. — Indonesia, Sulawesi Tengah: Ranu River area, 27.i-20.iv.1980, sweeping clearings, M. J. D. Brendell, BM 1980-280 (zahlreiche Exemplare BM, NHMB); idem near Kolonodale, Gililana Village, $01^{\circ}55'S$, $121^{\circ}22'E$, 7-8.ii.1980, M. J. D. Brendell (6 BM); Sulawesi Utara: Dumoga Bone N.P., Mogogompa, i, iii und x.1985 (14 BM, 14 NHMB).

Der Holotypus von Champion (♀) ist ca. 10% grösser als die meisten mir vorliegenden Exemplare. Der Bau der Fühler, Punktierung von Halsschild und Flügeldecken stimmt mit dem Paralec-

typus ♀ von *rufonotaticeps* Pic überein, so dass ich *tondanus* Champion als Synonym betrachte.

Carphurus storki sp.n.
(Abb. 15)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Rothamsted light trap, site 2, 220 m., ii.1985 (BM). Paratypen: idem Edward's Camp, lowland forest, 664 m, at light, x.1985 (1 NHMB); idem Fog 1, tray 56 (Plot A), 5.ii.1985 (1 BM).

Einfarbig schwarz, nur die Fühlerglieder 1 bis 5 aufgehellt, 1 und 5 nur auf der Unterseite.

♂. Kopf mit den Augen so breit wie der Hals-schild, Stirne leicht gewölbt, an der Basis einige

feine Querrunzeln, davor ein paar Punkte, zwischen den Augen und nach vorne glatt, spärliche Punkte. Fühler (Abb. 15) knapp 3 mal so lang wie der Halsschild, Glieder 3 bis 10 gegen die Spitze deutlich verbreitert, ein wenig länger als breit, 2 schwach nach unten erweitert, kaum merklich schmäler als 3. Halsschild breiter als lang (19×17), Seiten nach vorne schwach verengt, kurz vor der Basis gegen diese verengt; Scheibe leicht gewölbt, vor der Basis quer eingedrückt, an dieser Stelle seitlich mit ein paar kurzen Querrunzeln, Rest glatt, wenige Haarpunkte sichtbar. Flügeldecken nach hinten ein wenig erweitert, 3 bis 3½ Tergite unbedeckt lassend, Punkte kaum angedeutet, erloschen gewirkt, nicht glatt.

♀. Fühler um $\frac{1}{3}$ kürzer als beim ♂.

Länge: 2.5-3 mm.

Die neue Art ist nahe mit *C. brunneiventris* (Pic) verwandt. Obwohl die Picsche Art nach 1 ♀ beschrieben wurde, ist *C. storki* leicht anhand des Halsschildes zu unterscheiden, dessen Quereindruck vor der Basis deutlich tiefer ist als bei *brunneiventris*. Außerdem ist er bei *brunnei-*

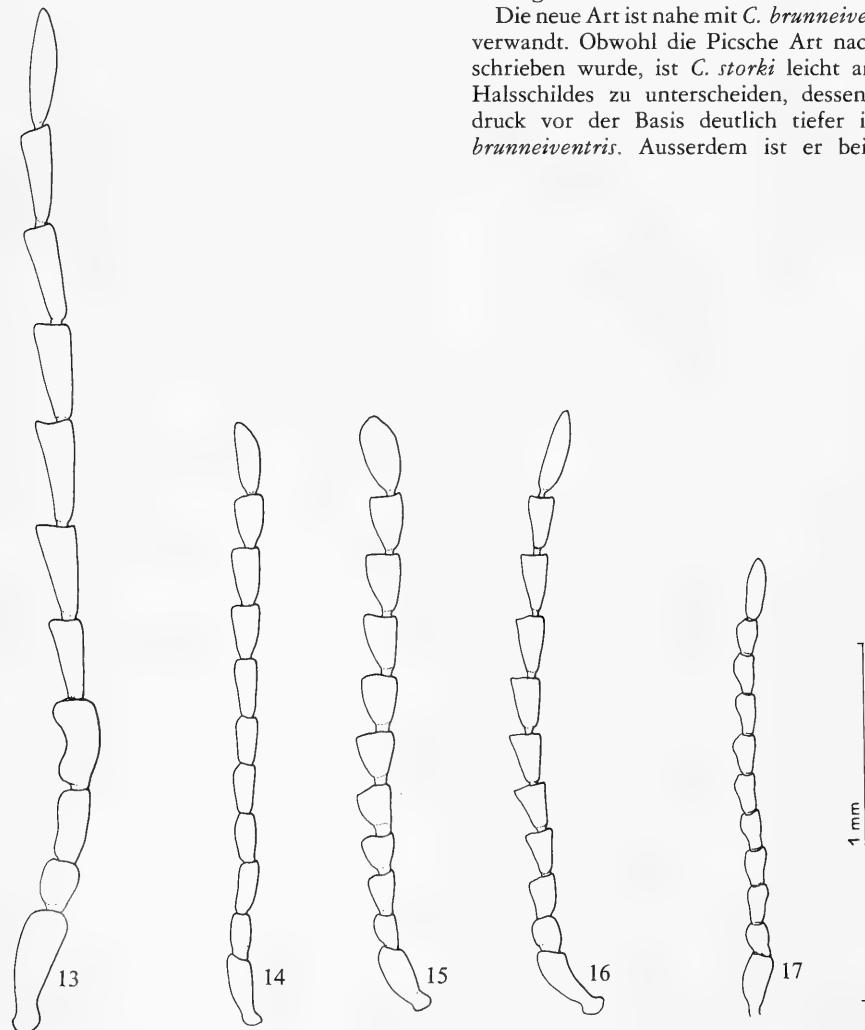


Abb. 13-17 — Fühler von *Carphurus*. 13-14, *C. brendelli* sp.n. (13, ♂. 14, ♀); 15, *C. storki* sp.n. ♂; 16, *C. lyali* sp.n. ♂; 17, Fühler von *Telocarphurus nebulosus* sp.n. ♂.

ventris vollständig glatt, bei *storki* zeigt er an den Seiten ein paar gröbere, fast erloschene Punkte und 2 bis 3 deutliche kurze Querrunzeln an den Seiten basal vor dem Quereindruck und eine grössere Anzahl dahinter. Der Kopf zwischen den Augen ist bei *storki* deutlicher punktiert als bei *brunneiventris*.

Carphurus lyali sp.n. (Abb. 16)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Gng. Ambang E.R. near Kotamobagu, Fog 7, 1200 m, 18.ii.1985 (BM).

♂. Oberfläche und Abdomen einfärbig schwarz bis schwarzbraun; Fühler schwarz, Glied gelb, 2 leicht aufgehellt. Beine braun.

Kopf mit den Augen viel breiter als der Halsschild, Stirne ziemlich flach, Stirnbasis gegen die Schläfen und an denselben mit deutlichen Querrunzeln, diese dringen nach vorne neben den Augen bis fast über die Fühlerwurzeln; zwischen den Augen ganz wenige Punkte, vor der Stirnbasis gröbere und zahlreichere Punkte. Fühler (Abb. 16) fast 4 mal länger als der Halsschild, Glieder 3 bis 10 schwach gezahnt, 2 ungefähr so breit wie 3. Halsschild ein wenig breiter als lang (13×12), Seiten wenig gerundet, kurz vor der Basis ein wenig verengt; Scheibe gewölbt, vor der Basis kurz, flach eingedrückt; Oberfläche glatt mit wenigen Haarpunkten. Flügeldecken ca. 4 Tergite unbedeckt lassend, ziemlich grob und dicht, teils etwas erloschen punktiert.

Länge: 2.7 mm.

Neben *C. testaceolimbatus* sp.n. zu stellen.

Telocarphurus Wittmer, 1939

Telocarphurus nebulosus sp.n. (Abb. 17)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Fog 5, tray 9 (Plot C), 400 m, 11.ii.1985 (BM).

♂. Kopf, Halsschild, Schildchen und grösster Teil der Unterseite schwarz; Fühler schwarz, 2 erste Glieder gelb; Flügeldecken schwarz, basale 2/5 verschwommen gelblichbraun; Beine braun bis schwärzlich.

Kopf mit den Augen breiter als der Halsschild, Stirnbasis sehr schmal und Schläfen gewirkt, Oberfläche glatt mit ein paar Punkten. Fühler (Abb. 17) ca. 3 1/3 mal so lang wie der Halsschild, Glieder 3 bis 10 zur Spitze leicht verbreitert, unter sich ungefähr von gleicher Länge, erst bei 10 deutlich kürzer als 3. Halsschild nur wenig breiter als lang (12×11), Seiten nur schwach gerundet, Oberfläche glatt mit wenigen Punkten, außer je einer langen Borste in den Basalecken ist die Scheibe mit einer Anzahl

kürzerer Haare besetzt. Flügeldecken verkürzt, ca. 4 Tergite unbedeckt lassend, fast glatt, leicht durchsichtig, zerstreut, ungefähr wie der Halsschild behaart.

Länge: 2 mm.

Noch ein wenig kleiner und zarter gebaut als *T. strigilatus* Wittmer, von diesem durch den glatten Halsschild und die viel kürzeren Fühler leicht zu unterscheiden.

Paracarphurus Wittmer, 1953

Paracarphurus sulawesiensis sp.n. (Abb. 18)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Clarke Camp, lower montane forest, 1140 m, iv.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, v.1985 (1 BM); idem Edward's Camp, lower montane forest, 664 m, x.1985 (1 NHMB).

♂. Braun, letzte 4 bis 5 Fühlerglieder ganz schwarz, manchmal auch die Spitzen ein paar weiterer Glieder angedunkelt, Hinterschenkel fast bis zu den Knien und manchmal auch die Basis der Mittelschenkel kurz schwarz; Unterseite schwarz, letzte 3 Sternite orange, Tergite orange, ausgenommen das viertletzte, das schwarz ist.

Kopf mit den Augen kaum merklich breiter als der Halsschild, Stirne nur schwach gewölbt, über jeder Fühlerwurzel ein flacher Eindruck, Oberfläche fast glatt, Stirnbasis mit ein paar Querrunzeln. Fühler die Schulterbeulen ein wenig überragend, Glieder 3 bis 10 gezahnt, 3 ein wenig länger als 2. Halsschild ein wenig länger als breit, Seiten vor der Mitte am breitesten, hier gerundet, dann zur Basis leicht verschmälert, Basis vor dem Basalrand leicht aufgewölbt; Oberfläche glatt, feine zerstreute Haarpunkte sichtbar. Flügeldecken verkürzt, etwas mehr als doppelt so lang wie der Halsschild, jede Spitze breit gerundet, fast in der Mitte, etwas vor der Spitze befindet sich ein runder Eindruck mit leicht erhöhtem Rand, vor dem Eindruck eine Anzahl sehr lange weissliche, nach hinten gerichtete Haare (Abb.18), die an der Spitze leicht verbreitert sind; Punktierung mässig grob, Punkte teils zusammenfließend, Zwischenräume glatt. Tarsalkamm kurz, so lang wie das Tarsenglied 1.

Länge: 5 mm.

Diese neue Art ist am nächsten mit *P. neobritanicus* Wittmer verwandt, sie hat ähnlich gerundete Spitzen der Flügeldecken, die jedoch mit einem grösseren Eindruck versehen sind, der weiter hinten als bei *neobritanicus* liegt. Bei *neobritanicus* fehlen die langen Haare hinter dem Eindruck, dafür befindet sich hier eine kurze breite Borste und zwischen dem Eindruck und dem Hinterrand eine grosse, fast runde, fast glatte Fläche, die bei *sulawesiensis* fehlt.

Falsolaius Pic, 1917*Luzonotroglops* Pic, 1924 syn.n.

Der Vergleich des Holotypus von *Luzonotroglops carinatus* Pic (spec. typ. von *Luzonotroglops*) mit dem Holotypus von *Falsolaius curtipennis* Pic (spec. typ. von *Falsolaius*), beide im MP, hat obige Synonymie ergeben. Die beiden Arten *F. carinatus* (Pic) und *F. curtipennis* Pic bleiben bestehen. Alle seit 1924 als *Luzonotroglops* beschriebenen Arten sind zu *Falsolaius* zu stellen.

Die Gattung *Falsolaius* Pic ist nahe mit der Gattung *Neocarphurus* Lea verwandt, die hauptsächlich über Australien verbreitet ist, sie unterscheidet sich von letzterer nur durch den einfachen Kopf, dem Gruben oder sonstige Bildungen fehlen.

***Falsolaius sulawesiensis* sp.n.**

(Abb. 19, 21)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Gng. Ambang F.R. near Kotamobagu, lower montane forest, ca. 1750 m, 18-24.v.1985, yellow pan trap (BM).

Paratypen: Gleicher Fundort wie Holotypus, 18-24.v.1985 (1 BM - ♀ in copula mit Holotypus -, 2 NHMB); Gng. Muajat, summit area, ca. 1780 m, vi.1985, malaise trap (1 BM).

Kopf und Halschild braun, letzterer an der eingeschnürten Stelle bis zur Basis meistens mehr oder weniger aufgehellt; Fühler braun, die letzten 2 oder 3 Glieder angedunkelt; Schildchen und Flügeldecken braun, letztere oft mit einem schwach ange dunkelten Flecken auf jeder Schulterbeule, der stark reduziert sein kann und nur noch neben dem Schildchen sichtbar ist, bei den Exemplaren mit gut entwickelten Schulterflecken ist auch eine dunkle Mittelbinde vorhanden, die die Seiten und die Naht nicht immer erreicht und je eine quere Makel an den Spitzen; Abdomen dunkelbraun, letztes Tergit heller; Beine braun, Schienen meistens ein wenig angedunkelt, manchmal auch die Oberseite der Schenkel.

♂. Kopf mit den Augen breiter als der Halsschild, Stirne schwach gewölbt, Basis kurz fein längsgestrichelt, Wangen ebenfalls gestrichelt, Rest des Kopfes größtenteils chagriniert, zwischen den Augen

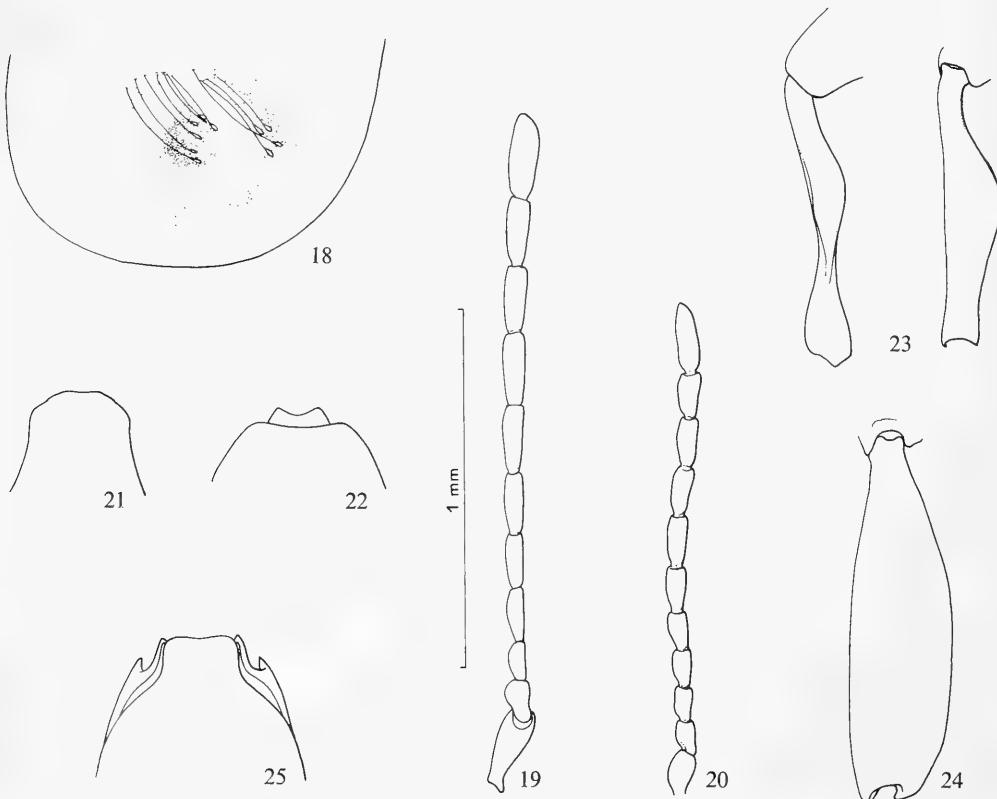


Abb. 18-25. — 18, Spitze der Flügeldecke von *Paracarphurus sulawesiensis* sp.n. ♂; 19-20, Fühler von *Falsolaius* (19, *F. sulawesiensis* sp.n. ♂, 20, *F. semicostatus* sp.n. ♂); 21-22, Letztes Tergit von *Falsolaius* (21, *F. sulawesiensis* sp.n. ♂; 22, *F. semicostatus* sp.n. ♂); 23-25: *Dromanthomorphus cyaneus* Pic ♂. (23, Vordertibie von oben, daneben im Profil; 24, Mitteltibie; 25 letztes Tergit).

eine glattere Stelle, ein paar lange aufrechtstehende Borsten vorhanden. Fühler (Abb. 19) fast 3 mal so lang wie der Halsschild, Glieder 3 bis 10 zur Spitze nur ganz wenig verbreitert, 4 länger als 3. Hals-schild länger als breit (20×17), Seiten stark gerundet verengt, basales Drittel eingeschnürt und dann zur Basis wieder ein wenig verbreitert, Seitenkante vorne gegen den breiten und stark gewölbten Teil am deutlichsten, gegen die Basis verschwindend, der ganze eingeschnürte Teil ist körnig gewirkt, matt, der vordere Teil glatt, vereinzelte Haarborsten vorhanden. Flügeldecken nach hinten wenig verbreitert, 4 bis 5 Tergite unbedeckt lassend, Schultern stark vorstehend mit einer Längskante, die nach den Schulterbeulen verschwindet, Spitze jeder Decke schwach beulenartig aufgewölbt, Oberfläche körnig gewirkt, matt, mit zahlreicher schwarzen Borsten, besetzt als Kopf und Hals-schild. Letztes Tergit (Abb. 21) ziemlich vorstehend, Spitze breit gerundet.

♀. Wie das ♂ gebaut, sogar die Fühler sind kaum merklich kürzer.

Die neue Art gehört zu den Arten mit glattem Halsschild, wenigstens dem vorderen Teil und angedeuteter Beule vor der Spitze der Flügeldecken. Sie unterscheidet sich von *F. unituberculatus* (Wittmer) durch hellere Gestalt, den an der basalen, verengten Stelle des Halsschildes, der fein gewirkt, matt ist und die nur angedeutete beulenartige Verdickung vor der Spitze der Flügeldecken, um nur die wichtigsten Unterscheidungsmerkmale aufzuzählen.

Falsolaius semicostatus sp.n. (Abb. 20, 22)

Material. — Holotypus: ♂, Indonesia, Sulawesi Utara: Dumoga Bone N.P., Fog 5, trays 13, 14, 18, 26, 32, 54, 97 (Plot C), 11.ii.1985 (BM). Paratypen: Gleicher Fundort wie Holotypus, 11.ii.1985 (4 BM, 3 NHMB); idem Fog 8, trays 7, 11, 13, 15, 16, 18, 19, 20, 22, Mangrove, 3 km S. of Labuanika, $0^{\circ}52'N$ - $23^{\circ}57'E$, 25.ii.1985 (7 BM, 3 NHMB); idem Plot C, ca. 400 m, lowland forest, malaise trap up trees, 18-25.ix.1985 (1 NHMB); idem Plot B, ca. 300 m, lowland forest, malaise trap up trees, 6-13.iii.1985 (1 BM); idem Edward's Camp, lowland forest, 664 m, malaise trap, 26.iv-7.vi.1985 (1 BM).

Kopf dunkelbraun, vorderer Teil mehr oder weniger aufgehellt; Halsschild dunkelbraun, seltener hellbraun, der eingeschnürte Teil an der Basis aufgehellt (gelblich); Fühler gelb, letzte 2 bis 5 Glieder angedunkelt; Schildchen und Flügeldecken braun, dunkelbraun oder seltener hellbraun, variabel aufgehellt, z.B. mit einer queren Aufhellung vor der Mitte, die an der Naht unterbrochen sein kann und einer breiteren dahinter, oder die hintere ist schmäler als die vordere, bei dunkelbraunen Exemplaren sind Aufhellungen kaum sichtbar oder nur ganz schwach, manchmal nur hinten sichtbar; Abdomen

dunkelbraun, die beiden letzten Tergite oder nur das letzte kann hell sein; Beine dunkelbraun, oder heller braun bis gelb, dann können die Schenkel, manchmal auch die Schienen einen dunkleren Längswisch aufweisen.

♂. Kopf mit den Augen ein wenig breiter als der Halsschild, Stirne leicht gewölbt, Oberfläche chagriniert (64X). Fühler (Abb. 20) fast doppelt so lang wie der Halsschild, Glieder 3 bis 10 zur Spitze nur ganz wenig verbreitert, 4 ein wenig länger als 3. Hals-schild länger als breit (20×15), Seiten gerundet verengt, basales Drittel eingeschnürt und dann zur Basis wieder ein wenig verbreitert, Seitenkante auf dem vorderen Teil der Einschnürung kurz oder nur angedeutet; Oberfläche am eingeschnürteten Teil fein chagriniert, Rest glatt. Flügeldecken fast parallel, Schulterbeulen vorstehend, mit einer Längskante, die ungefähr nach $\frac{1}{3}$ verschwindet, vor jeder Spitze ein Querwulst; Oberfläche fast glatt, Behaarung fein gelblich nicht dicht, dazwischen ganz vereinzelte, kurze aufstehende dunkle Borsten. Letztes Tergit (Abb. 22) sehr kurz und breit, Spitze ausgerandet.

♀. Fühler ein wenig kürzer als beim ♂, sonst wie dieses gebaut.

Länge: 2-2.3 mm.

Nahe mit *F. sulawesiensis* Wittmer verwandt, Gestalt kleiner, die Seitenkanten an der Einschnürung auf dem Halsschild sind weniger ausgeprägt, die Querwulste an den Spitzen der Flügeldecken sind grösser und das letzte Tergit ist viel kürzer, Spitze ausgerandet.

Dromanthomorphus Pic, 1921

Flabellapalochrus Pic, 1923 syn. n.

Die Gattung *Dromanthomorphus* wurde von Pic nach 1 ♀ aus Nord-Celebes, Toli-Toli, Nov.-Dez. 1895, H. Fruhstorfer, beschrieben, Holotypus im MP. Im Material des BM fand sich 1 ♂, das zu *D. cyaneus* Pic gehört. Pic hat bei der Beschreibung der Gattung *Flabellapalochrus* nach 1 ♂ übersehen, dass er diese Gattung bereits nach 1 ♀ unter dem Namen *Dromanthomorphus* beschrieben hatte, sodass erstere Gattung in Synonymie verfällt. Alle als *Flabellapalochrus* beschriebenen Arten sind in die Gattung *Dromanthomorphus* Pic zu stellen.

Dromanthomorphus cyaneus Pic (Abb. 23-25)

Dromanthomorphus cyaneus Pic, 1921: 7.

Material. — Indonesia, Sulawesi Utara: Dumoga-Bone N.P., Plot B. ca. 300 m, lowland forest, malaise trap, ix.1985 (1 ♂ BM).

Da das ♂ noch nicht beschrieben wurde, folgt hier dessen Beschreibung:

♂. Kopf blau, Vorderkopf bis kurz über den Fühlerwurzeln, Oberlippen und Maxillarpalpen gelb; Fühler gelb, die kammartigen Fortsätze der Glieder 4 bis 6 schwarz, 7 bis 11 ganz schwarz; Halsschild und Schildchen blau; Flügeldecken weisslichgelb, Basis und Spitzen ein wenig breiter, Seiten und Naht schmal blau; Abdomen gelblich, letztes Tergit braun, Spitze schwach, schmal angedunkelt; die 4 Vorderbeine gelb, Hinterbeine dunkel, an den Knien leicht aufgehellt.

Kopf mit den Augen schmäler als der Halsschild an der Basis, Stirne leicht, regelmässig gewölbt, zwischen den Augen eine kleine Grube, Oberfläche ziemlich grob punktiert. Fühler von Glied 4 an lang gekämmt, 3 stark nach innen gerundet erweitert. Halsschild breiter als lang, Seiten gerundet, ein wenig nach vorne verengt, Scheibe gewölbt; Oberfläche unregelmässig, wenig dicht punktiert. Flügeldecken nach hinten leicht erweitert, fast ganz erloschen punktiert, Behaarung doppelt, greis, kurz auf der hellen Fläche, abstehende Borsten dunkel. Letztes Tergit (Abb. 25) stärker sklerotisiert als die nachfolgenden, lang, Spitze vorstehend, an den Seiten ausgeschnitten. Vordertibien (Abb. 23) von oben gesehen, vor der Spitze sehr schmal, wie zusammengedrückt, im Profil gesehen (Abb. 23) nach oben gerundet verbreitert; Mitteltibien (Abb. 24) stark verbreitert, von oben gesehen ohne Aushöhlungen.

Länge: ca. 4.3 mm.

Dromanthomorphus ranuensis sp.n.

Material. — Holotypus: ♂, Indonesia, Sulawesi Tengah: near Morowali, Ranu River area, 27.i-20.iv.1980, Vert. series 30 m actinic code, 13.iii.1980, also at flight, M. J. D. Brendell (BM); Paratypen: Gleicher Fundort wie Holotypus (17 BM, 10 NHMB).

Kopf, Halsschild, Schildchen und Flügeldecken schwarz mit mehr oder weniger deutlichem blauem Metallschimmer, auf letzteren manchmal eine längliche, schlecht begrenzte Aufhellung; Fühler schwarz, erste 6 Glieder gelb, bei 4 bis 6 sind die Kämme zunehmend angedunkelt; Beine schwarz, Vordertarsen gelblich; Abdomen schwarz, die letzten 2 bis 3 Sternite gelblich.

♂. Kopf mit den halbkugelförmigen Augen breiter als der Halsschild; Stirne schwach gewölbt; Oberfläche dicht punktiert. Fühler um ca. ¼ kürzer als die Flügeldecken, von Glied 4 an in zunehmender Länge gekämmt, 3 länglich, zur Spitze verbreitert, diese stumpf, ein wenig gerundet. Halsschild breiter als lang, Seiten gerundet, nach vorne etwas verengt, Vorderecken etwas stärker gerundet als die Basalecken; Oberfläche uneben, weniger deutlich als der Kopf punktiert. Flügeldecken langgezogen, nach hinten schwach verbreitert; Oberfläche teils schwach runzlig, teils fast matt. Alle Beine ohne Auszeichnungen.

♀. Augen normal, nicht vergrössert, Kopf mit den Augen praktisch gleich breit wie der Halsschild. Fühler um ¼ kürzer als beim ♂, stumpf gezähnt.

Länge: ca. 3.3 mm.

Neben *D. saigonensis* (Pic) und *D. impressithorax* (Pic) zu stellen, die beide ebenfalls einfache Beine besitzen (♂). Die neue Art ist durchwegs grösser als die beiden erwähnten Arten von Pic, die nur 2.5 und 2.8 mm messen.

Laius Guérin, 1830

Bestimmungstabelle für die auf Sulawesi vorkommenden Arten

1. Kleine Arten, weniger als 3 mm messend; Flügeldecken mit 2 oder 4 kleinen weissen Flecken 2
- Grosse Art, 4 mm messend; Flügeldecken einfarbig blauviolett *L. cyanus* Guérin
2. Wangen einfach, ohne Gruben; Flügeldecken mit 4 weissen Flecken 3
- Wangen mit einer tiefen Grube, die sich bis zum Hinterrand der Augen erstreckt; Flügeldecken mit 2 weissen Flecken vor der Mitte. Fühlerglieder 1-3, Abb. 29 *L. fossigerus* sp.n.
3. Seiten des Halsschildes ungefähr in der Mitte mit einem kräftigen Zahn 4
- Seiten des Halsschildes einfach, ohne Zahn. Fühlerglieder 1-3, Abb. 27 *L. ranuensis* sp.n.
4. Vorderkopf breit, über den Fühlerwurzeln leicht abgesetzt aufstehend, Wangen flach; Fühlerglied 3 kürzer, oben nicht längseingedrückt (Abb. 26) *L. ribbei* Pic
- Vorderkopf nach vorne verschmälert, über den Fühlerwurzeln nicht erhöht, Wangen ausgehöhlt; Fühlerglied 3 länger, oben längseingedrückt (Abb. 28) *L. denticollis* sp.n.

Laius fossigerus sp.n.

(Abb. 29)

Material. — Holotypus: ♂, Indonesia, Sulawesi Tengah: near Morowali, Ranu River area, 27.i-20.iv.1980, M. J. D. Brendell (BM).

♂. Kopf, Halsschild, Schildchen und Flügeldecken schwarz, letztere mit 2 weissen ovalen, isolierten Querflecken auf der vorderen Hälfte; Fühler schwarz, Glieder 2 bis 7 ganz, 8 basale Hälften gelb; Beine schwarz, alle Tarsen leicht aufgehellt.

Kopf mit den stark vorstehenden Augen breiter als der Halsschild, Schläfen neben den Augen tief ausgehölt, zwischen dem Hinterrand des Auges und der Aushöhlung ragt eine schmale, wenig hohe Leiste auf (von vorne gesehen gut sichtbar), Längsleiste zwischen den Augen am deutlichsten sichtbar.

bar, Wangen breit, flach; Oberfläche fein gewirkt, matt. Fühler (Abb. 29) die Schulterbeulen nur wenig überragend, Glied 1 gegen die Spitze verbreitert, 2 kaum sichtbar, 3 länglichoval, vor der Spitze ein ovaler Eindruck, vor der Basis ein langer, schmaler, schräg nach aussen gerichteter Fortsatz. Halsschild ein wenig länger als breit, Seiten leicht gerundet, Scheibe gewölbt, an der Basis quer eingedrückt; Oberfläche fein chagriniert, matt. Flügeldecken nach hinten leicht erweitert, ziemlich dicht gewirkt, matt.

Länge: 2.5 mm.

Dies ist die einzige mir bekannte schwarze *Laius*-Art mit weissen Flecken auf den Flügeldecken, deren Wangen tief ausgehöhl sind.

Laius ranuensis n.sp.

(Abb. 27)

Material. — Holotypus: ♂, Indonesia, Sulawesi Tengah: near Morawali, Ranu River area, vert. series 20 m actinic, 14.ii.1980, M. J. D. Brendell (BM).

♂. Kopf schwärzlich, der vordere Teil der Wangen und der Vorderstirne gelb; Fühler gelb bis gelb-braun, die letzten 4 Glieder leicht angedunkelt; Halsschild, Schildchen und Flügeldecken schwärzlich, die letzteren mit 4 queren, weissen Flecken, die vorderen erreichen die Seiten, die hinteren erreichen sie nicht ganz; Beine dunkel, die Spitze der Vorderschenkel, die Vordertibien und alle Tarsen gelb.

Kopf mit den Augen ungefähr so breit wie der Halsschild, Stirne zuerst leicht gewölbt, dann bis zur Vorderstirne fast glatt, Längsleiste vorhanden,

an der Kopfbasis beginnend, nicht sehr deutlich sichtbar, Wangen sehr breit; Oberfläche gewirkt, matt. Fühler (Abb. 27) die Schulterbeulen ein wenig überragend, Glied 1 keulenförmig, gegen die Spitze nach aussen erweitert, 2 versteckt, 3 länglichoval, an der Basis innen in eine kleine stumpfe, behaarte Spitze ausgezogen, Oberfläche längseingedrückt. Halsschild kaum merklich breiter als lang, Seiten fast in gerader Linie gegen die Basis verengt; Scheibe gerundet, vor der Basis schwach quer eingedrückt, Oberfläche wie der Kopf gewirkt. Flügeldecken nach hinten nur wenig erweitert, wie der Halsschild gewirkt.

Länge: ca. 2.5 mm.

Neben *L. denticollis* Wittmer zu stellen, verschieden durch die fehlenden Dorne an den Seiten des Halsschildes und die anders geformten Fühler.

Laius ribbei Pic

(Abb. 26)

Laius ribbei Pic, 1910: 84.

Der Holotypus im MP trägt folgende Etikette: S. Celebes, Pangie, C. Ribbe, 1882. Die Abb. 26 zeigt die Fühlerglieder 1 bis 3.

Laius denticollis n.sp.

(Abb. 28)

Material. — Holotypus: ♂, Indonesia, Sulawesi Tengah: near Morawali, Ranu River area, 27.i.-20.iv.1980, M. J. D. Brendell (BM). Paratypen: Gleicher Fundort wie Holotypus (8 BM, 4 NHMB); Sulawesi Utara: Dumoga-Bone N.P., lowland forest, ca. 200 m, ii.1985.

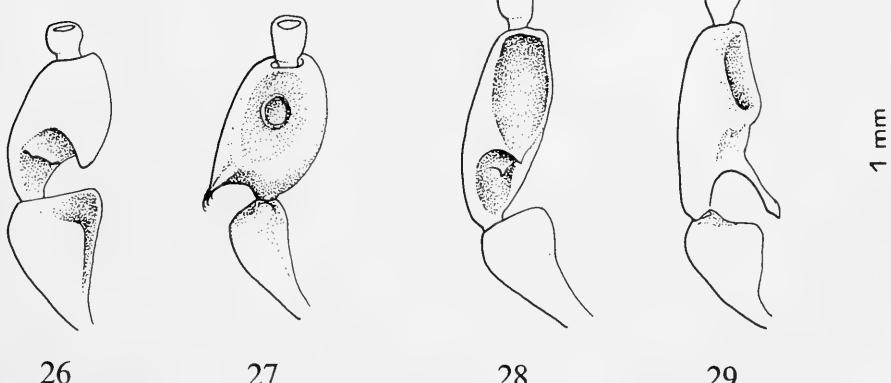


Abb. 26-29. — Fühlerglieder 1 bis 3 von *Laius* ♂. — 26, *L. ribbei* Pic; 27, *L. ranuensis* sp.n.; 28, *L. denticollis* sp.n.; 29, *L. fossigerus* sp.n.

♂. Kopf, Halsschild, Schildchen und Flügeldecken schwarz, letztere mit 4 weissen, isolierten, fast runden Flecken, die 2 vorderen vor der Mitte, die 2 hinteren hinter der Mitte; Fühler schwärzlich, Glied 1 auf der Unterseite, 3 fast vollständig und die folgenden 2 bis 4 auf der Innenseite bräunlich; Beine schwärzlich, Tarsen ganz leicht aufgehellt.

Kopf mit den Augen kaum merklich schmäler als der Halsschild an den seitlichen Zähnen, Stirne gewölbt, eine feine Längsleiste beginnt an der Stirnbasis und erstreckt sich bis ungefähr zur Mitte, die Stirne ist vorne neben den Augen leicht gerundet aufgewölbt und dazwischen flach eingedrückt, der grösste Teil der Wangen ist breit ausgehöhlten, so dass die Vorderstirne sehr schmal ist; Oberfläche gewirkt, matt. Fühler (Abb. 28) die Schultern ein wenig überragend, Glied 1 keulenförmig gegen die Spitze nach aussen erweitert, 2 fast ganz versteckt, 3 fast länglichoval, in der Mitte längseingedrückt, an der Basis mit einem kurzen, leicht aufwärts gerichteten Zahn. Halsschild breiter als lang, Seiten zur Basis verengt, jederseits fast in der Mitte ein kräftiger Zahn, Oberfläche wie der Kopf gewirkt. Flügeldecken nach hinten nur wenig erweitert, wie der Halsschild gewirkt, matt.

♀. Wie das ♂ gefärbt. Kopf einfach; Fühlerglied 1 zur Spitze verbreitert, jedoch nicht nach innen erweitert, 3 so lang wie beim ♂, oben nicht eingedrückt, Zahn an den Halsschildseiten kleiner.

Länge: 2.5-2.8 mm.

Neben *L. celebensis* Pic und *L. dentatithorax* Pic zu stellen, die beide verschieden gebauten Kopf und Fühler besitzen.

LITERATUR

Champion, G. C., 1923. A revision of the Malayan and Indian species of the melyrid subfamily Carphurinae represented in the Hope Collection at Oxford and in the British Museum in London (Coleoptera). – Annals and Magazine of Natural History 9(12): 1-54.
 Motschulsky, V. de, 1859. Études Entomologiques 8: 1-64.
 Pic, M., 1910. Sur les "Laius" Guer. à quatre macules blanches élytrales. – Échange 26: 83-84.
 Pic, M., 1917. Descriptions abrégées diverses. – Mélanges exotico-entomologiques 25: 1-24.
 Pic, M., 1924. Coléoptères nouveaux des Philippines. – Bulletin de la Société Entomologique de France: 1924: 230-231.

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TAXONOMY, LIFE HISTORY AND DISTRIBUTION OF THREE CLOSELY RELATED SPECIES OF THE GENUS *CALATHUS* (COLEOPTERA: CARABIDAE)

Aukema, B., 1990. Taxonomy, life history and distribution of three closely related species of the genus *Calathus* (Coleoptera: Carabidae). – Tijdschrift voor Entomologie 133: 121-141, figs. 1-18, tabs. 1-15 [ISSN 0040-7496]. Published 14 December 1990.

After cross-breeding experiments between *Calathus melanocephalus*, *C. mollis* *mollis* and *C. mollis* *cinctus* and analysis of morphological data of these taxa, *Calathus cinctus* is established as a good species. An identification key for the three species is given, main morphological differences are depicted and data on their biotope, life history, distribution and time trends are provided and discussed.

Berend Aukema, Pomona 66, 6708 CC Wageningen, The Netherlands.

Keywords. – Carabidae; *Calathus*; *cinctus*; *melanocephalus*; *mollis*; cross-breeding; identification key; life history; distribution maps; time trends.

In the past the status of *Calathus melanocephalus* (Linnaeus, 1758) and *C. mollis* (Marsham, 1802) as different species has been questioned many times, mainly because of the frequent occurrence of morphologically intermediate specimens. Schatzmayr (1937), Lindroth (1943) and Wiebes-Rijks (1959) treated them as distinct species, whereas Friederichs (1907) and Gersdorf (1937) could not find any distinguishing character between both taxa at all. Furthermore the existence of a morphologically intermediate form *cinctus* Motschulsky, 1850 (= *erythroderus* Gemminger & Harold, 1868), established as a subspecies of *mollis* by Lindroth (1945), masks the status of these taxa.

This so-called *melanocephalus* group belongs to *Neocalathus*, established as a subgenus of the genus *Calathus* Bonelli by Ball and Negre (1972) with *Calathus melanocephalus* as the type species. For nomenclature in the *melanocephalus* group see Aukema (1990) and Aukema & Luff (1990).

The discovery at Wijster of populations of a *cinctus*-like *Calathus* on abandoned agricultural fields in the surroundings of the Biological Station of the Agricultural University Wageningen (van Dijk 1978) offered a good opportunity for studying its taxonomic relationship with both *melanocephalus* and *mollis*, and its life history.

Moreover, in the present study cross-breeding experiments between these three taxa were carried out to elucidate their taxonomic status. Morphological data (including biometrics) were used to support the resulting classification.

The taxonomic characters given in literature to

distinguish *melanocephalus* and *mollis* from each other are:

1. The coloration of the pronotum in comparison to the head (and elytra): clear rufous, contrasting with the black head and elytra in *melanocephalus*, and piceus to brown and not or little contrasting in *mollis*. In the typical form of *melanocephalus* and in *mollis* all appendages are pale. However, a varying degree of melanism may occur in *melanocephalus*, in which the pronotum is more or less infuscated, from possessing only a faint cloud at the centre to being black with only narrowly translucent margins (in that case also the appendages are melanistic, at least tarsi brown, often also the main part of legs and palpi, as well as middle antennal segments (Jeannel 1942, Lindroth 1974, 1986, Vereshchagina 1985)).
2. The shape and size of the right paramere: widened at the tip and hooked at the extreme apex in *melanocephalus* and not widened and unarmed or with a very small hook at the apex in *mollis* (Lindroth 1974, 1986, Freude 1976, Vereshchagina 1985). Differences in internal and external morphology of the vesica are indicated by Lindroth (1943) and Vereshchagina (1985).
3. The dimensions of the metepisterna: short in *melanocephalus* (ca. 1.6 times as long as wide in both brachypterous and macropterous specimens), and longer in macropterous specimens of *mollis* (ca. 1.8 times as long as wide) (Jeannel 1942, Lindroth 1974, Freude 1976, Vereshchagina 1985).

4. The shape of the pronotum: more slender, with the greatest width usually before the middle and clearly narrowed towards the base in *mollis*, and less slender, with the greatest width in or behind the middle and sides less convergent in the basal half in *melanocephalus* (Freude 1976, Lindroth 1986, Vereshchagina 1985).
5. The shape of the elytra: longer oval (more stretched), with lateral margin curved and gradually tapering apically in *mollis*, and shorter oval, with sides almost parallel and broadly rounded apically in *melanocephalus* (Freude 1976, Lindroth 1986).

According to both Lindroth (1974, 1986) and Freude (1976) the subspecies *mollis cinctus* (at the time known as *mollis erythroderus*) can be distinguished from *mollis mollis* by the entirely rufous pronotum, contrasting with the piceus to brown head and elytra. Van Dijk (1978) furthermore mentions a difference in the colour of the sternites between *cinctus* and *melanocephalus*. Material collected in the field was studied to evaluate the usefulness of these characters for identification.

Finally museum collections were revised in order to get an impression of the distribution of the species involved in The Netherlands. Due to misidentification in the past, existing distribution maps of the taxa concerned (Turin, Haeck & Hengeveld 1977) have to be replaced.

In this paper the taxonomic status of the three taxa mentioned above is unravelled and the data presented lead to the conclusion that *Calathus cinctus* can be considered as a good species. Data on habitat, life history and distribution of *cinctus*, *melanocephalus* and *mollis* are given.

MATERIAL AND METHODS

Cross-breeding experiments

Single-pair crosses between all possible combinations of the three taxa were carried out during 1978/1979 and 1979/1980 under approximately outside conditions in an outdoor insectary. In 1978/1979 selected pairs were kept either in glass



Fig. 1. Collecting sites of *Calathus cinctus*, *C. melanocephalus* and *C. mollis* in The Netherlands. – 1, Drenthe (Dwingeloo, Kraloo, Nijl); 2, Ameland (Buren, Nes); 3, Texel ('t Horntje); 4, Oost-Flevoland (Ecological Reserve); 5, Amsterdam (Bijlmermeer); 6, Wassenaar (Meijendel); 7, Schouwen (Haamstede).

jars on sieved peat litter (group 1) or in petri dishes in ground peat litter (group 2). In the first case newly emerged larvae were gathered from the peat litter as described by van Dijk (1979a), whereas for the second group eggs were separated from the peat according the sieve-wash method of Mols et al. (1981). Eggs were incubated at a constant temperature of 19°C. Larvae were moved to glass tubes in which they were reared individually in peat litter in the outdoor rearing facility. During the winter months (from the end of November until the end of March) the larvae were moved to a climate room at 5°C under short day (LD 10/14) conditions. Single-pair crosses of males and females of the same taxon served as control groups. Crosses and origin of the beetles used are given in table 1.

Offspring of crosses performed by van Dijk (1978) in 1977/1978 and specimens collected in the field before the start of the reproduction period (tenerals in the case of females; *cinctus* from Dwingeloo, *melocephalus* from Kraloo, and *mollis* from Voorne) were used as starting material (table 1). Furthermore, offspring of females inseminated in the field (*cinctus* from Nijl and Dwingeloo, and *melocephalus* from Oost-Flevoland) were reared in order to get virgin females as starting material for the next crossing programme.

In 1979/1980 crosses were carried out comparable to those of group 2 of the preceding year. The food, however, was changed from pieces of mealworm to small maggots. Again offspring of females inseminated in the field (*mollis* from the West Frisian Island of Ameland) was reared. Information on these crosses is summarized in table 2. Collecting sites are depicted in fig. 1.

Morphology

Material collected in the field was studied to check the validity and usefulness of characters given in literature for identification of the species concerned. Samples of the following localities were used:

Calathus cinctus: Drenthe: Dwingeloo (Noordenveld), Ruijten (Nijl); Friesland: Ameland (Buren, Nes); N-Holland: Texel ('t Horntje); Zuid-Holland: Wassenaar (Meijendel) and Zeeland: Schouwen (Haamstede).

Calathus melocephalus: Friesland: Ameland (Buren, Nes); Drenthe: Dwingeloo (Noordenveld), Ruijten (Nijl, Kraloo); Flevoland: Oost-Flevoland (Oecologisch Reservaat); N-Holland: Texel ('t Horntje), Amsterdam (Bijlmermeer).

Calathus mollis: Friesland: Ameland (Buren, Nes); Z-Holland: Wassenaar (Meijendel) and Zeeland: Schouwen (Haamstede).

Measurements were made with a Wild M5 stereo-microscope provided with a calibrated ocular micrometer. The following measurements were taken (magnification between brackets):

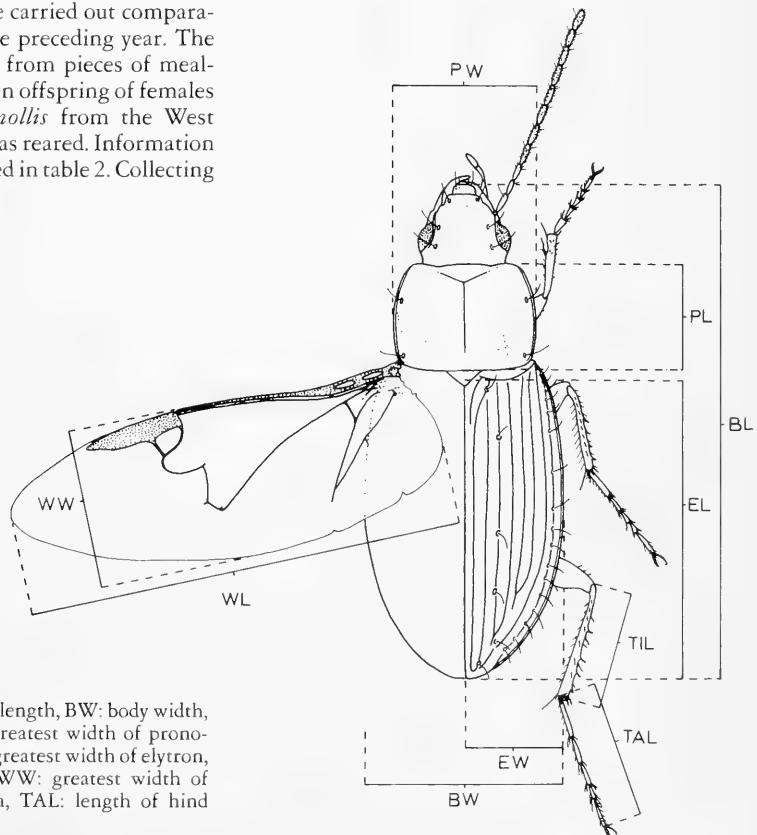


Fig. 2. Measurements. BL: body length, BW: body width, PL: length of pronotum, PW: greatest width of pronotum, EL: length of elytron, EW: greatest width of elytron, WL: greatest length of wing, WW: greatest width of wing, TIL: length of hind tibia, TAL: length of hind tarsus.

Table 1. Single-pair crosses between and within *Calathus cinctus*, *C. melanocephalus* and *C. mollis* in 1978/1979. cin: *cinctus*; mel: *melanocephalus*; mol: *mollis*; lw: long winged; sw: short winged; N: number of crosses; NL: ibid., producing larvae; L: number of larvae produced and reared; LR: number of larvae reared; B: number of beetles reared.

PARENTS		Origin		N	NL	L	B
Species/Wing-morph		Males	Females				
	Males	Females					
Group 1	mel sw	cin lw	Kraloo (28-6-1978)	F_1 -offspring 1978 ¹⁾	4	-	-
	mel sw	cin lw	Kraloo (28-6-1978)	Dwingeloo (19-7-1978, teneral)	1	-	-
	mel sw	cin sw	Kraloo (28-6-1978)	F_1 -offspring 1978	5	-	-
	cin lw	mel sw	F_1 -offspring 1978	Kraloo (28-6-1978, tenerals)	5	1	41
	cin sw	mel sw	F_1 -offspring 1978	Kraloo (28-6-1978, tenerals)	5	1	32
	cin lw	mel sw	Nuil (4-8-1978)	F_1 -offspring 1978	6	-	-
Group 2	cin lw	mel sw	F_1 -offspring 1978	F_1 -offspring 1978	6	-	-
	cin lw	mel sw	Nuil (4-8-1978)	F_1 -offspring 1978	6	-	-
	cin sw	mel sw	F_1 -offspring 1978	F_1 -offspring 1978	2	-	-
	cin sw	mel sw	Nuil (4-8-1978)	F_1 -offspring 1978	7	-	-
	mol lw	mel lw	Voorne (end July 1978) ²⁾	F_1 -offspring 1978	1	-	-
	mol lw	mel sw	Voorne (end July 1978)	F_1 -offspring 1978	5	-	-
Controls	cin lw	mol lw	Voorne (end July 1978)	Voorne (end July 1978)	5	2	20
	mel sw	mol lw	Kraloo (4-8-1978)	Voorne (end July 1978)	5	2	27
	cin lw	cin lw	Parents 1977 ¹⁾	F_1 -offspring 1978	6	5	283
	cin sw	cin lw	F_1 -offspring 1978	Parents 1977	6	5	149
	cin lw	no males	no males	Dwingeloo (23-8/22-9-1978)	16	16	734
	cin lw	no males	no males	Nuil (23-8/22-9-1978)	5	5	253
	cin lw	cin sw	F_1 -offspring 1978	Parents 1977	6	4	114
	cin sw	cin sw	F_1 -offspring 1978	F_1 -offspring 1978	6	6	295
	cin sw	no males	no males	Dwingeloo (7-9-1978)	1	1	49
	cin sw	no males	no males	Nuil (23/31-8-1978)	4	3	147
	mel sw	mel sw	Kraloo (30-8-1978)	Kraloo (30-8-1978)	6	6	60
	mel lw	no males	O-Flevoland (20-9-1978)	O-Flevoland (20-9-1978)	14	13	489
	mel sw	no males	O-Flevoland (27-9-1978)	O-Flevoland (27-9-1978)	13	10	371
LR							

¹⁾: parents and offspring of crosses carried out by Th. S. van Dijk

²⁾: material collected by A. van Tiggele

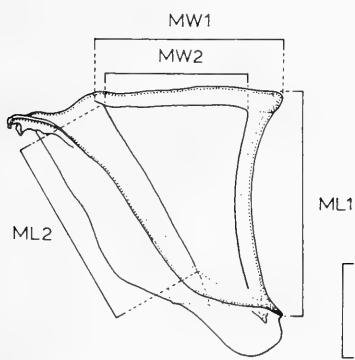


Fig. 3. Measurements of met-episternum. ML1, ML2: length; MW1, MW2: width. Scale 0.5 mm.

- length and width of the body (12): length between tip of mandibles and apex of elytra and greatest width over elytra (fig. 2: BL and BW).
 - length and width of the pronotum (25): median length and greatest width (fig. 2: PL and PW).
 - length and width of the (right) elytron (12): EL and EW in fig. 2. EW was calculated as half the greatest body-width ($0.5 \times BW$).
 - length and width of the (right) wing (12): greatest length and greatest width (fig. 2: WL and WW).
 - length and width of the (right) met-episternum (50) as shown in fig. 3 (length: ML1, ML2; width: MW1, MW2).
 - length of the (right) hind tibia and of the (right) hind tarsus (25) (fig. 2: TIL and TAL).
 Elytra, wings, met-episterna and hind-legs were removed from the body for proper measurement in a flat plane. Wings were put on a slide in alcohol and unfolded with a fine brush.

From these measurements ratios between length and width of the body (BL/BW), width and length

Table 2. Single-pair crosses between and within *Calathus cinctus*, *C. melanocephalus* and *C. mollis* (1979/1980). cin: *cinctus*; mel: *melanocephalus*; mol: *mollis*; lw: long winged; sw: short winged; N: number of crosses; E: number of eggs laid; NL: number of crosses producing larvae; L: number of larvae produced and reared; LR: number of larvae reared; B: number of reared beetles.

PARENTS									
Species/Wing-morph		Origin		Females	N	E	NL		
Males	Females	Males							
mel lw	cin lw	Oost-Flevoland (11-10-1978)	F_1 -offspring 1979		4	422	3	68	—
mel sw	cin lw	F_1 -offspring 1979 (O-Flevoland)	F_1 -offspring 1979		4	591	—	—	—
mel sw	cin lw	F_1 -offspring 1979 (Kraloo)	F_1 -offspring 1979		4	320	—	—	—
mel lw	cin sw	Oost-Flevoland (11-10-1978)	F_1 -offspring 1979		4	91	—	—	—
mel sw	cin sw	F_1 -offspring 1979 (O-Flevoland)	F_1 -offspring 1979		4	219	—	—	—
mel sw	cin sw	F_1 -offspring 1979 (Kraloo)	F_1 -offspring 1979		4	201	—	—	—
mol lw	cin lw	Ameland (28-6-1979)	F_1 -offspring 1979		4	184	—	—	—
mol lw	cin sw	Ameland (28-6-1979)	F_1 -offspring 1979		4	254	—	—	—
cin lw	mel lw	F_1 -offspring 1979	Oost-Flevoland (25-10-1978)		2	59	—	—	—
cin lw	mel lw	Ameland (28-6-1979)	Oost-Flevoland (25-10-1978)		2	216	—	—	—
cin sw	mel lw	F_1 -offspring 1979	Oost-Flevoland (25-10-1978)		2	229	—	—	—
cin sw	mel lw	Ameland (28-6-1979)	Oost-Flevoland (25-10-1978)		2	418	1	173	—
cin lw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (O-Flevoland)		2	23	—	—	—
cin lw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (O-Flevoland)		2	58	—	—	—
cin lw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (Kraloo)		2	218	2	77	—
cin lw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (Kraloo)		2	14	—	—	—
cin sw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (O-Flevoland)		2	15	—	—	—
cin sw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (O-Flevoland)		2	50	1	26	—
cin sw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (Kraloo)		2	87	—	—	—
cin sw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (Kraloo)		2	4	—	—	—
mol lw	mel lw	Ameland (28-6-1979)	Oost-Flevoland (25-10-1978)		4	181	1	25	—
mol lw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (O-Flevoland)		4	57	—	—	—
mol lw	mel sw	Ameland (28-6-1979)	F_1 -offspring 1979 (Kraloo)		4	59	—	—	—
Control groups								LR	
mel lw	mel lw	F_1 -offspring 1979	F_1 -offspring 1979		4	1173	4	238	85
mel sw	mel lw	F_1 -offspring 1979 (O-Flevoland)	F_1 -offspring 1979		4	1084	4	240	135
mel sw	mel lw	F_1 -offspring 1979 (Kraloo)	F_1 -offspring 1979		4	1279	4	217	139
mel lw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (O-Flevoland)		4	1113	4	239	92
mel sw	mel sw	F_1 -offspring 1979 (O-Flevoland)	F_1 -offspring 1979 (O-Flevoland)		4	959	4	240	130
mel sw	mel sw	F_1 -offspring 1979 (Kraloo)	F_1 -offspring 1979 (O-Flevoland)		4	665	4	224	136
mel lw	mel sw	F_1 -offspring 1979	F_1 -offspring 1979 (Kraloo)		4	682	4	160	96
mel sw	mel sw	F_1 -offspring 1979 (O-Flevoland)	F_1 -offspring 1979 (Kraloo)		4	1079	4	240	132
mel sw	mel sw	F_1 -offspring 1979 (Kraloo)	F_1 -offspring 1979 (Kraloo)		4	920	4	240	112
cin lw	cin lw	F_1 -offspring 1979	F_1 -offspring 1979		2	468	2	120	43
cin lw	cin lw	Ameland (28-6-1979)	F_1 -offspring 1979		1	232	1	60	20
cin sw	cin lw	F_1 -offspring 1979	F_1 -offspring 1979		2	639	2	85	41
cin sw	cin lw	Ameland (28-6-1979)	F_1 -offspring 1979		1	509	1	60	13
cin lw	cin sw	F_1 -offspring 1979	F_1 -offspring 1979		2	496	2	116	68
cin lw	cin sw	Ameland (28-6-1979)	F_1 -offspring 1979		1	216	1	60	20
mol lw	no males	Ameland (28-6-1979)			28	573	9	309	194

of the pronotum (PW/PL), pronotum width and body width (PW/BW), length and width of the elytra (EL/EW), length of the elytra and body length (EL/BL), length and width of the wings (WL/WW), wing-length and length of the elytra (WL/EL), length and width of the met-episterna (ML2/MW2), and the ratio between the lengths of

the hind tarsus and hind tibia (TAL/TIL) were estimated.

Special attention was paid to the coloration of the beetles, the size and shape of the right paramere and to the number of dorsal punctures in the third elytral interval.

Habitat and life history

Details of the habitat and the life history of the species were derived from the analysis of field data (mixed populations of *cinctus* and *melanocephalus* from Dwingeloo, Ruinen and the West Frisian Island of Texel and populations of *cinctus* and *mollis* from the West Frisian Island of Ameland), from literature (populations of *melanocephalus* studied by Vlijm & van Dijk (1967), Vlijm et al. (1968) and van Dijk (1972, 1973)) and from breeding experiments with the three species under outside conditions carried out in 1981/1982 and 1982/1983.

Distribution

Calathus-material of this group from Dutch collections was revised to be able to get an impression of the distribution of the species in The Netherlands. Material from the following collections is included:

Museums and institutions: Zoölogisch Museum, Amsterdam; Rijksmuseum van Natuurlijke Historie, Leiden; Vakgroep Entomologie, Landbouwuniversiteit, Wageningen; Biologisch Station, Landbouwuniversiteit, Wijster.

Private collections: K. den Bieman, Bennekom; E. H. M. Bouvy, Beek; H. T. Edzes, Nijmegen; T. van Gijzen, Arnhem; Th. Heijerman, Wageningen; S. van Heijnsbergen, Naarden; Y. Jongema, Wageningen and A. P. J. A. Teunissen, Vlijmen.

Additional material was supplied by K. Alders, Arnhem; M. A. Baars, De Koog, Texel (Loopkeverwerkergroep Texel); Th. S. van Dijk, Wijster; P. J. M. Mols, Heteren and H. Turin, Renkum.

Time trends in the occurrence of the species (i. e. numbers of occupied 10 × 10 km squares of the distribution maps per decade since 1870) were estimated according to the method of Turin & den Boer (1988).

RESULTS

Cross-breeding experiments

In total 123 single-pair crosses were carried out: 59 between *cinctus* and *melanocephalus*, 47 between *cinctus* and *mollis* and 17 between *melanocephalus* and *mollis* (tables 1 and 2). None of these crosses produced adult offspring although in 5 (8.5 %), 3 (6.4 %) and 3 (17.6 %) cases respectively larvae were produced, which, however, never reached the third larval stage.

Table 3. Measurements (in mm) of short winged males of *Calathus cinctus* and *C. melanocephalus* from Texel. N: number of measurements.

MEASUREMENT	<i>cinctus</i>			<i>melanocephalus</i>			
	N	Mean	95% c.l.	N	Mean	95% c.l.	
Body	Length (BL)	20	6.79	6.59-6.98	20	6.66	6.51-6.82
	Width (BW)	20	2.71	2.64-2.77	20	2.67	2.61-2.73
	BL/BW	20	2.51	2.47-2.55	20	2.50	2.45-2.55
Pronotum	Length (PL)	20	1.64	1.61-1.68	20	1.68	1.65-1.72
	Width (PW)	20	1.99	1.95-2.04	20	2.11	2.06-2.15
	PW/PL	20	1.21	1.20-1.23	20	1.25	1.23-1.27
	PW/BW	20	0.74	0.73-0.74	20	0.79	0.78-0.80
Elytron	Length (EL)	20	4.18	4.07-4.29	20	4.09	4.00-4.18
	Width (EW)	20	1.35	1.32-1.38	20	1.33	1.30-1.36
	EL/EW	20	3.09	3.05-3.12	20	3.07	3.03-3.11
	EL/BL	20	0.62	0.61-0.62	20	0.61	0.60-0.63
Wing	Length (WL)	20	1.93	1.85-2.01	20	1.93	1.86-2.00
	Width (WW)	20	0.48	0.45-0.51	20	0.51	0.47-0.54
	WL/WW	20	4.05	3.86-4.24	20	3.86	3.65-4.07
	WL/EL	20	0.46	0.45-0.47	20	0.47	0.46-0.49
Met-episternum	Length (ML2) ¹⁾	20	0.76	0.74-0.78	20	0.70	0.68-0.73
	Width (MW2) ¹⁾	20	0.57	0.55-0.59	20	0.57	0.55-0.58
	ML2/MW2 (ME2)	20	1.34	1.32-1.36	20	1.24	1.22-1.27
Hindleg	Length tarsus (TAL)	20	2.07	2.01-2.13	20	2.02	1.98-2.06
	Length tibia (TIL)	20	2.02	1.98-2.07	20	1.98	1.94-2.01
	TAL/TIL	20	1.02	1.01-1.03	20	1.02	1.01-1.04

¹⁾: see fig. 3.

All control crosses (42 of *melanocephalus* and 30 of *cinctus*) crosses that produced larvae (respectively 100 % and 82 % for both years together), also produced adult offspring (tables 1 and 2). In 1979/1980 all crosses of both species produced offspring (table 2). In the case of *mollis* not sufficient material to carry out control crosses in the same way was available. However, of 28 females collected in the field (Ameland, Buren, 28.vi.1979) and kept without males under the same conditions as single-pair crosses, 9 produced larvae and offspring (table 2: 194 beetles from 309 larvae). The other 19 females (ten of which were tenerals at the time of capture) produced no or only a few unfertilized eggs, and were considered not to have been inseminated at all. Nevertheless it is clear from these results that also in the case of *mollis* the failure of single-pair crosses with *cinctus* and *melanocephalus* cannot be attributed to the rearing conditions used.

In 1979/1980 egg production was also estimated. It appeared that, although unfertilized females may produce a considerable number of eggs, the egg production of fertilized females generally is much higher (table 2). It is concluded that *cinctus*, *melanocephalus* and *mollis* show mutual reproductive isolation, and, therefore, have to be considered as distinct species.

Morphology

Biometric data, especially the ratio length/width of the met-episterna, have been used in attempts to separate the taxa of this group of closely related species (Gersdorf 1937, Wiebes-Rijks 1959). The establishment of *cinctus* as a valid species as the result of the breeding program necessitated a new attempt to find morphological differences between the three species. Concerning biometrics, however, two points have to be taken into account. Firstly general differences both between sexes (on average females are larger than males) and between wing-morphs (on average long winged specimens are larger than short winged specimens and differently shaped) exist in these species. Secondly, the way measurements are made should be described (and figured) in detail, which apparently is not normal practice. Lindroth (1974) and Freude (1976), for instance, use the ratio length/width of the met-episterna without indicating how to measure it, and do not point out the differences between sexes and between wing-morphs in a proper way.

Tables 3-6 list measurements and ratio's of both males and females of short as well as long winged *Calathus cinctus* and *C. melanocephalus* collected on Texel by M. A. Baars and of long winged *C. mollis* collected in the coastal dunes near Haam-

Table 4. Measurements (in mm) of short winged females of *Calathus cinctus* and *C. melanocephalus* from Texel. N: number of measurements.

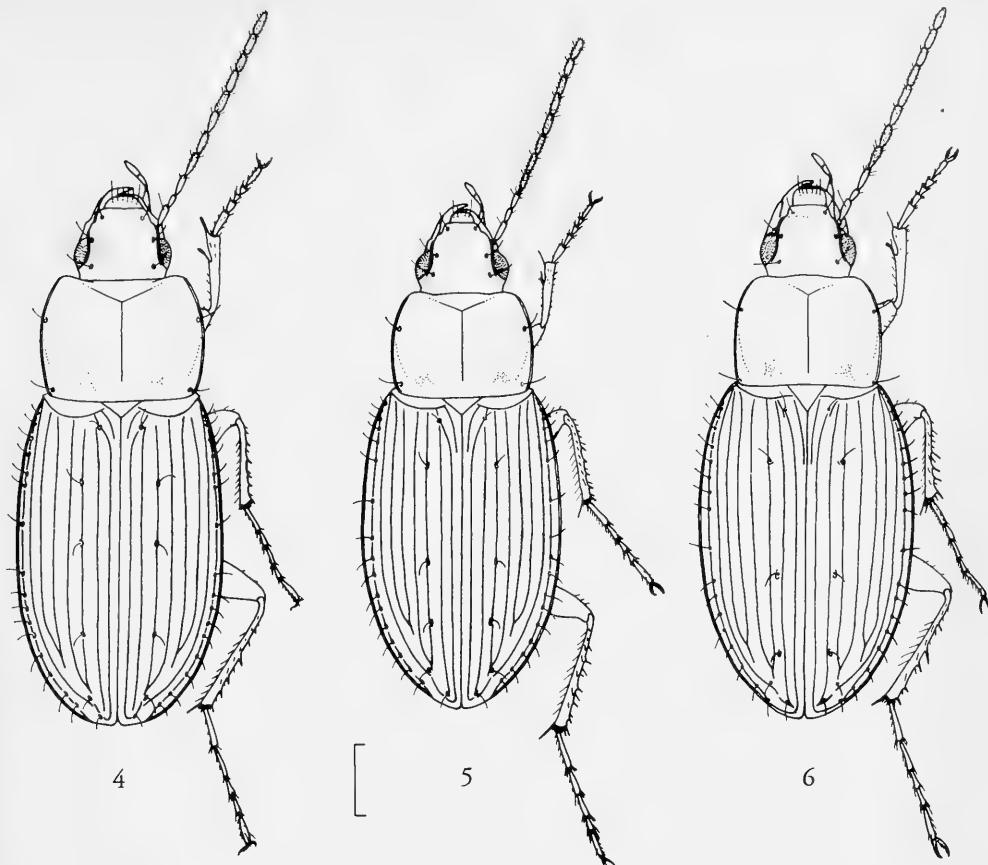
	MEASUREMENT	<i>cinctus</i>			<i>melanocephalus</i>		
		N	Mean	95% c.l.	N	Mean	95% c.l.
Body	Length (BL)	20	7.39	7.23-7.56	20	7.32	~7.18-7.46
	Width (BW)	20	3.01	2.94-3.09	20	2.95	2.91-3.00
	BL/BW	20	2.46	2.42-2.50	20	2.48	2.44-2.52
Pronotum	Length (PL)	20	1.77	1.73-1.81	20	1.79	1.76-1.82
	Width (PW)	20	2.19	2.13-2.24	20	2.28	2.24-2.32
	PW/PL	20	1.23	1.22-1.25	20	1.27	1.26-1.28
	PW/BW	20	0.73	0.72-0.74	20	0.77	0.76-0.78
Elytron	Length (EL)	20	4.54	4.44-4.64	20	4.45	4.36-4.53
	Width (EW)	20	1.51	1.47-1.54	20	1.48	1.46-1.50
	EL/EW	20	3.02	2.98-3.05	20	3.01	2.97-3.04
	EL/BL	20	0.61	0.61-0.62	20	0.61	0.60-0.62
Wing	Length (WL)	20	2.14	2.08-2.20	20	2.06	1.99-2.13
	Width (WW)	20	0.60	0.57-0.62	20	0.60	0.55-0.64
	WL/WW	20	3.61	3.48-3.75	20	3.49	3.32-3.65
	WL/EL	20	0.47	0.46-0.48	20	0.46	0.45-0.48
Met-episternum	Length (ML2)	20	0.83	0.80-0.85	20	0.76	0.74-0.77
	Width (MW2)	20	0.64	0.62-0.65	20	0.62	0.61-0.64
	ML2/MW2 (ME2)	20	1.30	1.27-1.33	20	1.22	1.20-1.24
Hindleg	Length tarsus (TAL)	20	2.08	2.03-2.12	20	1.97	1.92-2.01
	Length tibia (TIL)	20	2.07	2.03-2.12	20	2.02	1.98-2.06
	TAL/TIL	20	1.00	0.99-1.02	20	0.97	0.96-0.98

Table 5. Measurements (in mm) of long winged males of *Calathus cinctus* and *C. melanocephalus* from Texel and *C. mollis* from Haamstede. N: number of measurements.

		<i>cinctus</i>			<i>melanocephalus</i>			<i>mollis</i>		
	MEASUREMENT	N	Mean	95% c.l.	N	Mean	95% c.l.	N	Mean	95% c.l.
Body	Length (BL)	11	6.78	6.52-7.03	7	7.19	6.93-7.46	20	7.34	7.18-7.50
	Width (BW)	11	2.64	2.55-2.73	7	2.85	2.77-2.94	20	2.79	2.73-2.85
	BL/BW	11	2.57	2.52-2.62	7	2.52	2.44-2.60	20	2.63	2.61-2.66
Pronotum	Length (PL)	11	1.60	1.54-1.65	7	1.77	1.70-1.83	20	1.65	1.61-1.69
	Width (PW)	11	1.92	1.85-1.99	7	2.24	2.17-2.31	20	2.05	2.00-2.09
	PW/PL	11	1.20	1.18-1.23	7	1.27	1.25-1.29	20	1.24	1.23-1.25
	PW/BW	11	0.73	0.72-0.74	7	0.79	0.78-0.79	20	0.73	0.73-0.74
Elytron	Length (EL)	11	4.12	3.98-4.25	7	4.32	4.19-4.45	20	4.38	4.27-4.49
	Width (EW)	11	1.32	1.27-1.36	7	1.43	1.38-1.47	20	1.39	1.36-1.42
	EL/EW	11	3.12	3.07-3.18	7	3.03	2.98-3.09	20	3.14	3.11-3.18
	EL/BL	11	0.61	0.59-0.63	7	0.60	0.58-0.62	20	0.60	0.59-0.60
Wing	Length (WL)	11	6.26	5.89-6.62	7	7.10	6.86-7.85	20	6.61	6.39-6.83
	Width (WW)	11	2.36	2.23-2.50	7	2.68	2.63-2.74	20	2.46	2.37-2.54
	WL/WW	11	2.65	2.53-2.77	7	2.65	2.58-2.72	20	2.69	2.66-2.73
	WL/EL	11	1.52	1.47-1.57	7	1.64	1.62-1.67	20	1.51	1.49-1.53
Met-episternum	Length (ML2)	11	0.77	0.74-0.79	7	0.77	0.73-0.81	20	0.82	0.80-0.84
	Width (MW2)	11	0.57	0.55-0.59	7	0.60	0.58-0.62	20	0.58	0.56-0.59
	ML2/MW2 (ME2)	11	1.35	1.31-1.39	7	1.28	1.21-1.35	20	1.43	1.40-1.45
Hindleg	Length tarsus (TAL)	11	2.01	1.93-2.09	6	2.18	2.11-2.24	20	2.19	2.14-2.25
	Length tibial (TIL)	11	1.96	1.90-2.03	6	2.13	2.04-2.22	20	2.09	2.04-2.15
	TAL/TIL	11	1.02	1.01-1.04	6	1.02	1.00-1.05	20	1.05	1.04-1.06

Table 6. Measurements (in mm) of long winged females: *Calathus cinctus* and *C. melanocephalus* from Texel and *C. mollis* from Haamstede. N: number of measurements.

		<i>cinctus</i>			<i>melanocephalus</i>			<i>mollis</i>		
	MEASUREMENT	N	Mean	95% c.l.	N	Mean	95% c.l.	N	Mean	95% c.l.
Body	Length (BL)	11	7.04	6.78-7.30	20	7.85	7.72-7.97	20	8.03	7.86-8.19
	Width (BW)	11	2.87	2.74-3.00	20	3.15	3.12-3.18	20	3.18	3.10-3.25
	BL/BW	11	2.46	2.41-2.51	20	2.49	2.45-2.54	20	2.53	2.51-2.55
Pronotum	Length (PL)	11	1.67	1.60-1.74	20	1.89	1.86-1.92	20	1.77	1.74-1.81
	Width (PW)	11	2.09	1.99-2.20	20	2.43	2.40-2.47	20	2.28	2.22-2.34
	PW/PL	11	1.26	1.23-1.28	20	1.29	1.27-1.31	20	1.28	1.27-1.30
	PW/BW	11	0.73	0.72-0.74	20	0.77	0.76-0.78	20	0.72	0.71-0.72
Elytron	Length (EL)	11	4.34	4.18-4.50	20	4.80	4.72-4.88	20	4.81	4.71-4.92
	Width (EW)	11	1.43	1.37-1.50	20	1.57	1.56-1.59	20	1.59	1.55-1.62
	EL/EW	11	3.03	2.98-3.08	20	3.05	3.00-3.09	20	3.03	3.01-3.06
	EL/BL	11	0.62	0.61-0.63	20	0.61	0.60-0.62	20	0.60	0.60-0.60
Wing	Length (WL)	11	6.49	6.15-6.82	20	7.51	7.38-7.65	20	7.27	7.07-7.46
	Width (WW)	11	2.51	2.38-2.64	20	2.83	2.77-2.89	20	2.77	2.68-2.85
	WL/WW	11	2.58	2.52-2.64	20	2.65	2.62-2.69	20	2.63	2.60-2.65
	WL/EL	11	1.49	1.45-1.54	20	1.57	1.54-1.59	20	1.51	1.49-1.52
Met-episternum	Length (ML2)	11	0.82	0.77-0.88	20	0.83	0.81-0.84	20	0.92	0.88-0.94
	Width (MW2)	11	0.61	0.58-0.63	20	0.68	0.66-0.69	20	0.65	0.63-0.66
	ML2/MW2 (ME2)	11	1.36	1.31-1.41	20	1.22	1.21-1.24	20	1.42	1.39-1.45
Hindleg	Length tarsus (TAL)	11	2.00	1.89-2.06	20	2.09	2.06-2.11	20	2.21	2.16-2.25
	Length tibial (TIL)	11	1.97	1.92-2.08	20	2.18	2.15-2.22	20	2.19	2.15-2.23
	TAL/TIL	11	1.01	0.99-1.04	20	0.96	0.94-0.97	20	1.01	1.00-1.02



Figs. 4-6. Habitus of females of *Calathus*. - 4, *C. melanocephalus*; 5, *C. cinctus*; 6, *C. mollis*. Scale 1 mm.

stede (Province of Zeeland) by the author. The following conclusion can be drawn. Although there are some differences between the means (e. g. in the case of the ratio length/width of the metepisterna), these measurements (or ratios estimated from them) do not allow unambiguous identification due to significant individual variation and wide overlap in the ranges of measurements.

Table 7 summarizes length/width ratios (ME1: ML1/MW1 and ME2: ML2/MW2, see fig. 3) of long and short winged males and females of *cinctus* and *melanocephalus*, as well as of long winged males and females of *mollis* (all specimens collected or reared of the latter species turned out to be long winged) from localities mentioned above, as well as from a number of other localities too.

Although both ratios show a clear trend *melanocephalus* < *cinctus* < *mollis* for both males and females, the mutual overlap is so wide that identification on the basis of these ratios alone usually will not be possible. The observed differences between wing-morphs and sexes are smaller than

those between species (table 7). In general differences between species, wing-morphs and sexes are better illustrated by ratio ME2 than by ratio ME1.

Table 8 illustrates the variation in the number of dorsal punctures in the 3rd elytral interval of *cinctus* and *melanocephalus* from Texel and *mollis* from Haamstede. In both sexes and wing-morphs of *cinctus* considerable deviation (>50 %) from the standard number of three punctures in the third elytral interval was found, whereas the deviation in *melanocephalus* and *mollis* was relatively low (<40 %). Both the number and position of the punctures are also rather variable and certainly not of diagnostic value.

General coloration, shape of the elytra and shape of the right parameres are very constant and can be used to identify most specimens according to the key presented hereafter. Only a few long winged females of *cinctus* and *mollis* may give some problems in identification.

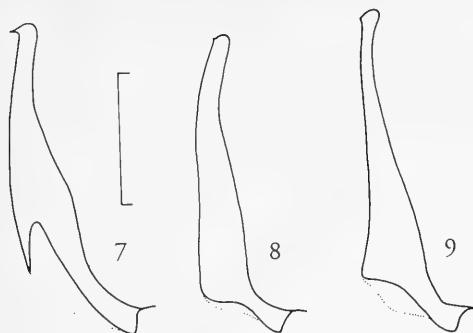
Table 7. Measurements of met-episterna: ratio length/width. ME1: ML1/MW1; ME2: ML2/MW2 (see fig. 3); sw: short winged; lw: long winged; N: Number of measurements.

MALES		Locality	N	ME1			ME2		
Wing-morph	Species			Range	Mean	95% c.l.	Range	Mean	95% c.l.
sw	<i>cinctus</i>	Nuil	30	1.06-1.18	1.11	1.10-1.12	1.28-1.46	1.36	1.35-1.38
		Noordenveld ¹⁾	27	1.03-1.22	1.11	1.09-1.13	1.19-1.47	1.34	1.31-1.37
		Texel	20	0.97-1.10	1.04	1.03-1.06	1.25-1.43	1.34	1.32-1.36
sw	<i>melanocephalus</i>	Oost-Flevoland	30	0.99-1.16	1.07	1.05-1.08	1.19-1.39	1.29	1.27-1.31
		Nuil	19	0.96-1.10	1.04	1.02-1.06	1.15-1.31	1.23	1.21-1.25
		Noordenveld ¹⁾	30	0.94-1.10	1.03	1.02-1.05	1.10-1.39	1.25	1.23-1.28
		Kraloo	9	0.98-1.10	1.04	1.01-1.06	1.16-1.29	1.24	1.20-1.28
		Bijlmermeer	17	1.03-1.14	1.07	1.06-1.09	1.23-1.40	1.27	1.25-1.30
lw	<i>cinctus</i>	Texel	20	0.95-1.07	1.02	1.00-1.03	1.15-1.32	1.24	1.22-1.27
		Nuil	30	1.02-1.19	1.12	1.11-1.13	1.27-1.47	1.39	1.37-1.41
		Noordenveld ¹⁾	30	1.04-1.26	1.14	1.12-1.16	1.18-1.57	1.37	1.33-1.40
lw	<i>melanocephalus</i>	Texel	11	1.00-1.11	1.07	1.05-1.09	1.28-1.46	1.35	1.31-1.39
		Oost-Flevoland	13	1.00-1.15	1.08	1.05-1.11	1.14-1.34	1.24	1.21-1.28
		Kraloo	2	1.09-1.12			1.39-1.45		
		Bijlmermeer	3	1.07-1.09			1.21-1.29		
lw	<i>mollis</i>	Texel	7	1.00-1.09	1.05	1.02-1.08	1.20-1.40	1.28	1.21-1.35
		Meijendel	14	1.15-1.25	1.19	1.18-1.21	1.33-1.52	1.43	1.40-1.47
		Haamstede	20	1.11-1.20	1.16	1.14-1.17	1.35-1.54	1.43	1.40-1.45
FEMALES									
sw	<i>cinctus</i>	Nuil	29	1.02-1.18	1.11	1.09-1.12	1.24-1.49	1.35	1.33-1.37
		Noordenveld ¹⁾	29	1.00-1.20	1.08	1.07-1.10	1.17-1.44	1.30	1.28-1.33
		Texel	20	0.92-1.07	1.01	0.99-1.02	1.14-1.30	1.30	1.27-1.33
sw	<i>melanocephalus</i>	Oost-Flevoland	30	0.98-1.16	1.05	1.04-1.07	1.12-1.35	1.25	1.22-1.27
		Nuil	30	1.00-1.10	1.04	1.03-1.05	1.14-1.39	1.25	1.23-1.27
		Noordenveld ¹⁾	30	0.98-1.22	1.06	1.04-1.09	1.16-1.39	1.27	1.24-1.29
		Kraloo	12	1.00-1.13	1.05	1.03-1.08	1.18-1.37	1.24	1.18-1.30
		Bijlmermeer	10	0.98-1.18	1.09	1.05-1.12	1.23-1.33	1.27	1.24-1.30
lw	<i>cinctus</i>	Texel	20	0.92-1.07	1.01	0.99-1.02	1.14-1.30	1.22	1.20-1.24
		Nuil	30	1.07-1.21	1.12	1.11-1.13	1.26-1.44	1.35	1.34-1.37
		Noordenveld ¹⁾	29	0.98-1.30	1.13	1.11-1.16	1.24-1.58	1.36	1.33-1.39
lw	<i>melanocephalus</i>	Texel	11	1.05-1.17	1.11	1.08-1.14	1.25-1.49	1.36	1.31-1.41
		Oost-Flevoland	30	0.97-1.13	1.06	1.04-1.07	1.12-1.41	1.26	1.24-1.28
		Kraloo	18	0.98-1.18	1.08	1.05-1.11	1.17-1.48	1.30	1.25-1.34
lw	<i>mollis</i>	Bijlmermeer	7	1.03-1.12	1.08	1.05-1.12	1.25-1.43	1.31	1.26-1.37
		Texel	20	0.95-1.08	1.03	1.01-1.04	1.17-1.30	1.22	1.21-1.24
		Meijendel	17	1.13-1.28	1.19	1.17-1.21	1.33-1.54	1.43	1.40-1.46
		Haamstede	20	1.05-1.24	1.16	1.15-1.18	1.29-1.61	1.42	1.39-1.45

¹⁾: measurements M. G. J. Oude Wesselink

Tabel 8. Number of punctures in 3rd elytral striae. N: number of observations; D: deviation (%) from standard number of punctures (3/3) in third striae; sw: short winged; lw: long winged.

Species	Sex	Wing morph	N	Punctures in 3rd elytral stria (right/left elytrum)										
				2/2	2/3	2/4	3/2	3/3	3/4	4/3	4/4	4/5	5/3	5/4
<i>cinctus</i>	males	sw	20	-	1	-	-	9	5	2	3	-	-	55.0
		lw	11	-	-	-	-	5	3	2	1	-	-	54.5
	females	sw	20	-	2	-	-	2	5	5	5	-	1	90.0
		lw	11	-	-	-	-	4	2	1	3	-	1	63.6
<i>melanocephalus</i>	males	sw	20	-	-	-	-	13	1	4	2	-	-	35.0
		lw	7	-	-	-	-	5	2	-	-	-	-	28.6
	females	sw	20	-	-	-	-	13	3	3	1	-	-	35.0
		lw	20	-	-	-	-	14	3	2	1	-	-	30.0
<i>mollis</i>	males	lw	20	1	2	-	-	17	-	-	-	-	-	15.0
	females	lw	20	1	1	1	-	13	11	1	1	-	-	35.0



Figs. 7-9. Right parameres of *Calathus*. - 7, *C. melanocephalus*; 8, *C. cinctus*; 9, *C. mollis*. Scale 0.5 mm.

In all three species the females are less shining than the males, due to a denser microsculpture of usually isodiametric meshes, which is most obvious on the elytra.

Key to the species

1. Elytra bicoloured, with epipleura, base and dorsal punctures clear rufous, contrasting with the black dorsal surface. Sides of elytra almost parallel and broadly rounded apically (fig. 4). Pronotum more or less rufous, clearly contrasting with the black head and with the elytral surface. Sternites dark, contrasting with the rufous meso- and meta-thoracical structures. Males: right paramere widened and hooked at the tip (fig. 7). Vesica: fig. 10. Wings reduced or fully developed (rarely specimens with only one fully developed wing are found) (body length 6-8 mm)..... *melanocephalus*
- Elytra unicolor rufous to piceous brown, with sides evenly rounded (figs. 5-6). Little or no contrast in colour between pronotum and head and elytra, nor between sternites and meso- and meta-thorax. Males: right paramere not widened near the apex and unarmed or with a very small hook apically (figs. 8-9)..... 2
2. Pronotum slightly contrasting with the darker head and the elytra. Males: right paramere hooked, tip unarmed or nearly so (fig. 8). Vesica: fig. 11. Wings either fully developed or strongly reduced (body length 6-8.5 mm)..... *cinctus*
- Pronotum not contrasting with the head and the elytra. Males: right paramere almost straight with a very small hook apically (fig. 9). Vesica: fig. 12. Wings always full (body length 6.5-9 mm)..... *mollis*

Habitat and life history

Habitat

Calathus melanocephalus is mainly a species of open country, where it lives on different kinds of moderately dry soil with sparse vegetation, achieving its greatest abundance on sandy soils. It is a common inhabitant of dry meadows, grassland dunes and heaths; also on agricultural land and in thin forest, mainly of *Pinus* (Lindroth 1986) or *Betula* (den Boer pers. comm.). Den Boer (1977) in his subdivision of carabids in habitat groups classified *melanocephalus* as an F-species, i.e. mainly a species of heath and peat moor.

Calathus cinctus is mainly found in mixed populations with the preceding and/or the following species in dry meadows, dune grassland, agricultural land and waste land. Van Dijk (1986) classified *cinctus* as an H-species sensu den Boer (1977), i.e. an eurytopic species, which in most cases prefer localities significantly influenced by human activities (arable fields, pastures, farm yards, gardens and

Figs. 10-12. Vesica of *Calathus*. - 10, *C. melanocephalus*; 11, *C. cinctus*; 12, *C. mollis*. Scale 0.5 mm.

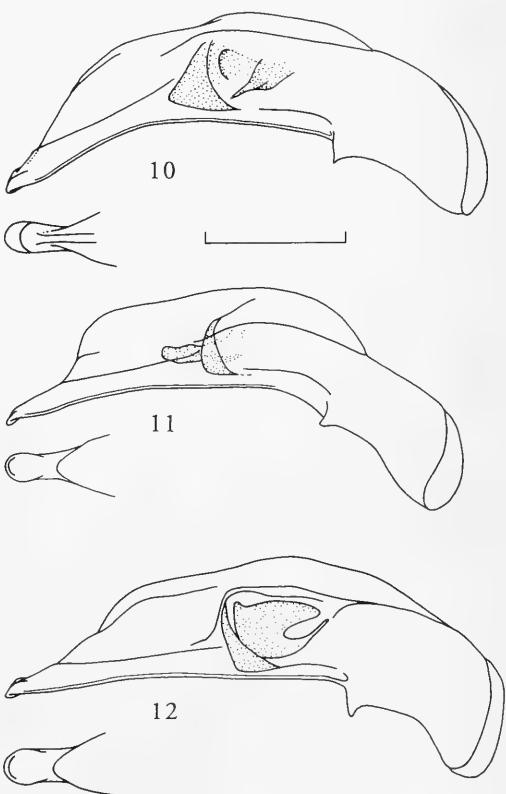


Table 9. Numbers and ratio of *Calathus cinctus* (cin) and *C. melanocephalus* (mel) in mixed populations.

Year	NUIL			SCHOONGELEGEN			TEXEL		
	Species			Species			Species		
	cin	mel	%cin	cin	mel	%cin	cin	mel	%cin
1973	11	30	26.8	8	71	10.1			
1974	13	29	31.0	3	54	5.3			
1975	35	64	35.4	6	23	20.7			
1976	16	20	44.4	22	39	36.1			
1977	34	24	58.6	39	31	55.7			
1978	59	67	46.8	172	112	60.6			
1979	12	34	26.1	3	62	4.6			
1980	2	19	9.5	-	40	-			
1981	-	16	-	-	30	-			
1982	-	6	-	-	72	-			
1983	1	-	-	-	84	-			
1984	-	6	-	-	50	-	82	19	81.1
1985	-	4	-	-	91	-	264	265	49.9
1986	-	18	-	-	102	-	133	310	30.0
1987							32	176	15.3
1988							6	74	7.5
Total	183	337		253	861		517	844	

Table 10. Weekly catches of *Calathus cinctus* and *C. melanocephalus* at Nuil, Drenthe in 1976. N: number of beetles; ND: number of females dissected; MNE: mean number of eggs in the ovaries of dissected females.

Date	<i>cinctus</i>						<i>melanocephalus</i>					
	Males			Females			Males			Females		
	N	N	ND	Young	Old	MNE	N	N	ND	Young	Old	MNE
7 Jul							1	1	1	1	-	11.0
14 Jul							5	4	4	3	1	4.3
21 Jul	-	1	1	1	-	-	8	12	8	6	2	11.1
28 Jul	-	-	-	-	-	-	14	18	10	9	1	15.9
4 Aug	-	1	1	1	-	15.0	7	10	9	8	1	14.4
11 Aug	-	-	-	-	-	-	11	25	11	7	4	21.5
18 Aug	1	2	2	2	-	23.0	35	26	10	7	3	22.6
25 Aug	3	2	2	1	1	35.0	46	17	10	9	1	23.0
1 Sep	13	15	15	7	8	20.2	42	34	10	8	2	25.8
8 Sep	10	16	16	9	7	33.9	11	24	10	10	-	21.5
15 Sep	21	20	20	15	5	26.5	18	21	10	10	-	17.6
22 Sep	27	18	18	16	2	17.8	23	18	13	12	1	18.8
29 Sep	16	8	8	5	3	18.3	22	4	4	3	1	10.8
6 Oct	17	10	10	9	1	15.4	9	2	2	0	2	16.5
13 Oct	12	20	18	10	8	11.2	6	10	10	9	1	2.0
20 Oct	4	6	6	4	2	9.8	2	1	1	1	-	-
27 Oct	2	6	6	3	3	8.0	2	4	2	2	-	-
3 Nov	-	1	1	1	-	-	1	-	-	-	-	-
10 Nov	2	3	1	1	-	-	3	1	-	-	-	-
Total	128	129	125	85	40		262	231	125	105	20	

roadside verges). In three cases a mixed population of *cinctus* and *melanocephalus* was observed during a period of several years: populations at Nuil and Dwingeloo (fields withdrawn from agricultural practice) and at the West Frisian Island of Texel (artificial dune grassland) (table 9). In all three cases, however, *cinctus* disappeared or nearly disappeared after a number of years of coexistence with *melanocephalus*. These data might suggest that

cinctus is better adapted to changing, unstable habitats than *melanocephalus*. At Nuil and Dwingeloo the treatments for impoverishing the amount of nutrients (annual mowing and removal of vegetation) most likely caused the decrease of *cinctus* (see also van Dijk 1986), while on the dune grassland at Texel a similar treatment might be responsible for the same kind of shift.

Calathus mollis is strictly confined to dry sandy

habitats in open country. It lives in sparse xerophilous vegetation, common on sand dunes along the coast, where it occurs in tufts of *Elymus* and *Amphibolia* in company with *Demetrias monostigma* Samouelle and *Dromius linearis* (Olivier) (Lindroth 1986; own observations), and only incidentally inland, e.g. on blown sands and other large sand deposits. In den Boer's subdivision (1977) *mollis* would be classified as an E-species (species of blown sands). In the coastal dune region as well as in inland blown sands mixed populations of *mollis* and *cinctus* and occasionally with both *cinctus* and *melanocephalus* occur.

Life history

Annual rhythms. – All three species show a similar type of development. They belong to the group of autumn breeders with a thermic hibernation parapause in the larvae and a photoperiodic aestivation parapause in the adults (Thiele 1977). As in most autumn breeders, adults of *melanocephalus* are almost strictly night active (Thiele 1977). Larvae as well as a varying part of the adults overwinter (Lindroth 1986). In northern and alpine areas, however, *melanocephalus* is a semivoltine spring breeder, instead of a univoltine autumn breeder, adapted to the shorter growing season of a cooler climate (Forsskål 1972, DeZordo 1979, Refseth 1988). Under these circumstances larvae of *melanocephalus* need almost two years to develop.

Reproduction period and age-composition. – Detailed information about the life history of *melanocephalus* is given by Vlijm & van Dijk (1967), Vlijm et al. (1968) and van Dijk (1972, 1973). Adults emerge in June and July, reproduce from August onwards and a varying part of these beetles hibernate to become active again in May-June, reproducing for the second time from July onwards. The total reproduction period covers the months July, August and September. Vlijm & van Dijk (1967) and Vlijm et al. (1968) estimated the second year category as about one third of the adult population at Schiermonnikoog, but this figure seem to show significant annual and local variation (van Dijk 1972, Baars & van Dijk 1984). Even three and four year old beetles were found by a mark-recap-

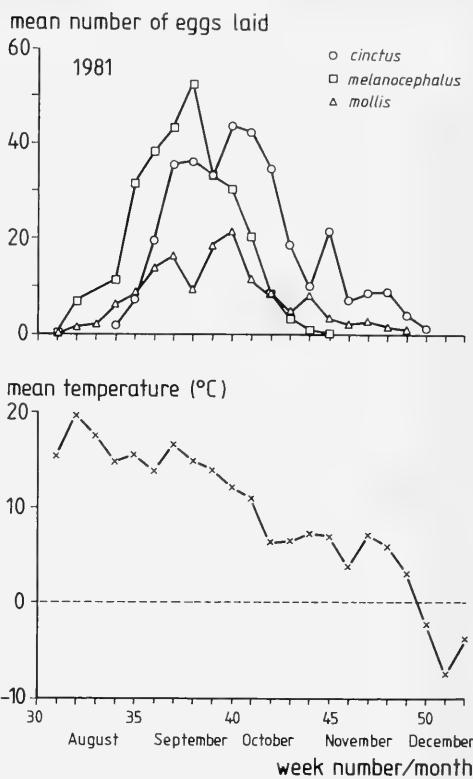


Fig. 13. Mean egg production of *Calathus cinctus* (29 females), *C. melanocephalus* (23 females) and *C. mollis* (16 females) and mean weekly temperature in 1981 under outside conditions.

ture experiment in a populations of *melanocephalus* (van Dijk 1979b), representing 26.5 and 0.5 % of the total catch during four years respectively.

Calathus cinctus was found to reproduce in Drenthe somewhat later than *melanocephalus* (August-November) (van Dijk 1978). From weekly pitfall samples of *cinctus* collected in 1976 at Nijl, 165 females caught between 21 July and 17 November were dissected and checked for their ovarian development. The main reproductive period, defined

Table 11. Reproduction period of *Calathus cinctus*, *C. melanocephalus* and *C. mollis* in outdoor breeding experiments. N: number of females.

Year	Species	N	REPRODUCTION PERIOD		
			Egg-laying period	(18 weeks)	Mean number of eggs > 10
1981	<i>cinctus</i>	29	12 Aug - 9 Dec	(18 weeks)	26 Aug - 21 Oct (9 weeks)
	<i>melanocephalus</i>	36	31 Jul - 6 Nov	(15 weeks)	7 Aug - 9 Oct (10 weeks)
	<i>mollis</i>	14	3 Aug - 7 Dec	(19 weeks)	31 Aug - 19 Oct (8 weeks)
1982	<i>cinctus</i>	30	16 Aug - 31 Jan	(25 weeks)	30 Aug - 22 Nov (13 weeks)
	<i>melanocephalus</i>	8	30 Jul - 22 Oct	(13 weeks)	13 Aug - 15 Oct (10 weeks)
	<i>mollis</i>	17	6 Aug - 3 Jan	(23 weeks)	20 Aug - 5 Nov (12 weeks)

Table 12. Egg production of *Calathus cinctus*, *C. melanocephalus* and *C. mollis* during the day at a constant temperature of 19° C and approximately natural day length (light period: 6:30-19:00 hours). D: dark period (black); L: light period (white).

Date	Time	D/L	<i>cinctus</i>					<i>melanocephalus</i>					<i>mollis</i>					Total
			1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	
14 Sep 1981 (start)	18.30	□■																54
15 Sep 1981	8.30	□□	3	2	2	7	7	6	1	6	13	2	1	3	1		0	0
	10.30	□□						5					9	1	1		15	1
	12.30	□□											1					0
	14.30	□□																0
	16.30	□□																0
	18.30	□□																0
	20.30	■■■■■	1										2	1				6
	22.30	■■■■■	4										6	6				19
16 Sep 1981	0.30	■■■■■	2					3	1				1	3	2	3		18
	2.30	■■■■■	5					1					6		1	8		21
	4.30	■■■■■	13					2					2		4	2		23
	6.30	■■■■■	1										1	3	1			6
	8.30	□□																2
	10.30	□□																1
	12.30	□□																0
	14.30	□□																0
	16.30	□□																0
	18.30	□□																0
17 Sep 1981	10.30	□□	4	4				14	2	22	13	6	17		4	7		93
	18.30	□□							3	1				2				6
Total			18	0	3	4	25	0	0	2	24	10	0	32	23	15	42	165

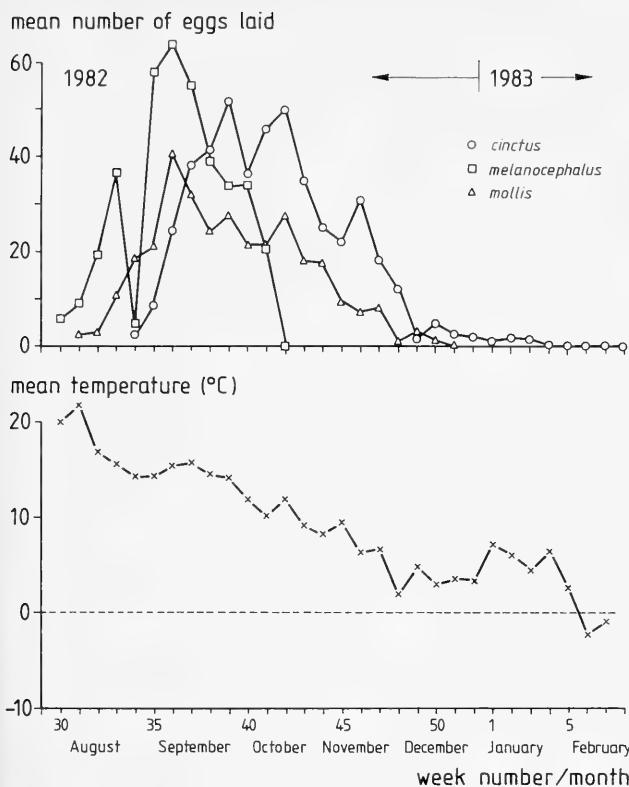


Fig. 14. Mean egg production of *Calathus cinctus* (30 females), *C. melanocephalus* (4 females) and *C. mollis* (17 females) and mean weekly temperatures in 1982/1983 under outside conditions.

here as the period in which the mean number of eggs in the ovaries is 10 or more, fell between the first week of August and the third week of October (table 10). Forty females (24.2 %) were classified as old females, reproducing for the second year. Comparable data for *melanocephalus* collected at the same site resulted in a main reproductive period between the third week of July and the first week of October and 16 % old females (table 10), of which only a single female caught on 13 October was not or no longer reproductive.

Calathus mollis was not studied in detail in this respect but hand catches on the West Frisian Island of Ameland on 27 May 1981 comprised old beetles only (29), whereas on 28 June 1979 about 12 % of the 248 beetles collected at the same site were just emerged teneralis. These data suggest a similar type of age composition of populations of this species.

In the laboratory a small part of the females of all three species kept individually even survived a second hibernation period and laid eggs during a third year.

Outdoor breeding experiments carried out in 1981 and 1982 also gave an impression of the reproductive period of the three species (table 11). Also in these experiments *melanocephalus* showed an earlier start and finish of the egg-laying period

than both *cinctus* and *mollis*. Differences between the results for the two years are attributed to different temperature conditions. In 1981, for instance, all females stopped egg production in the first third of December because of a sudden frost period (fig. 13). Due to the later start, *cinctus* and *mollis* suffered more from this event than *melanocephalus*. Under the more favourable weather conditions of 1982/1983 *melanocephalus* showed about the same reproduction period, whereas both *cinctus* and *mollis* were able to prolong their reproduction periods substantially under these conditions (fig. 14).

Data on egg production and larval development of the three species in relation to wing development, temperature and availability of food will be published elsewhere.

Daily rhythms. – Information about the daily activity of the species was derived from a small experiment in which the egg production was estimated every two hours under fixed temperature and daylength conditions. On 14 September 1981 eight reproductive females of *cinctus*, *melanocephalus* and *mollis*, collected at Ameland on 14 July, were transferred from the outdoor breeding house to an incubator adjusted at 19°C and a daylength of 14.75 hours (6.15-19.00 h). They were kept there with

males in single pairs for three days. In all three species egg production took place mainly during the dark hours (18.30-6.30 h); a very few eggs were also laid during the early morning hours (table 12).

Emergence of adults. – The outdoor breeding experiments also gave an impression of the emergence period of the adults (table 13). In 1982 almost all *cinctus*, *melanocephalus* and *mollis* emerged in the first two thirds of June, and in 1983 in the latter half of the same month. Van Dijk (1973) trapped teneral females of *melanocephalus* in the field as well as in enclosure experiments during a short period from 15 June onwards. Samples of *cinctus* and *mollis* collected on 28 June 1979 on the West Frisian Island of Ameland consisted of 75 % (102 of 138 specimens) and 11.7 % (26 of 248 specimens) ternals respectively.

Feeding. – Feeding behaviour and prey spectrum of *melanocephalus* were studied by Hengeveld (1980) by identifying food remains in the gut contents of beetles trapped in the field and killed instantly. From the diet components found, it appeared that *melanocephalus* is a polyphagous, but not exclusively carnivorous species (see also Melber 1983). Similar results were found by Smit (1957), Skuhravý (1959) and Hengeveld (1980) for the closely related *Calathus ambiguus* (Paykull), *C. eratus* Sahlberg and *C. fuscipes* (Goeze).

Dispersal. – Den Boer (1977) developed criteria to classify carabid beetles in three dispersal groups using data on wing development, wing-morph frequencies and actual flight (catches of flying beetles in window traps). A-species are those with a relatively low power of dispersal (monomorph brachypterous or wing-polymorphic species with a very low frequency (< 1%) of macropterous beetles). B-species have a relatively high power of dispersal due to their capability of flight (macropterous and wing-polymorphic species caught in window traps, see also van Huizen 1980), whereas C-species are the remaining species (macropterous

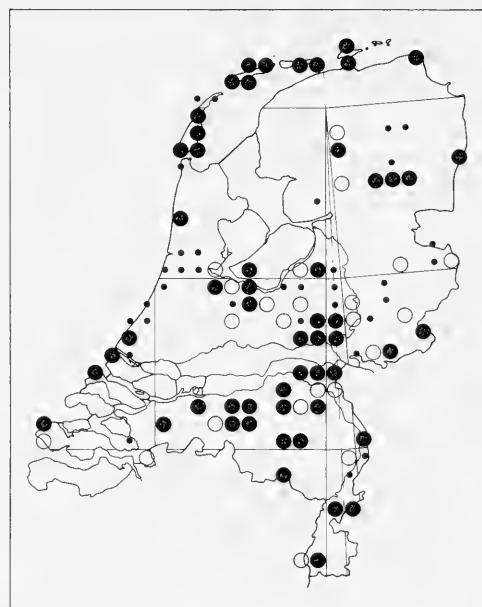


Fig. 15. Distribution of *Calathus cinctus* in The Netherlands. Symbols on this and the following maps: open circles: recorded before 1930 only; small dots: recorded between 1930 and 1960; large dots: recorded since 1960.

or wing-polymorphic with a high frequency of macropterous beetles, but never or rarely caught flying) with uncertain dispersal power.

The wing-dimorphic *cinctus* was caught in window traps (van Huizen 1980; den Boer et al. 1980) and consequently belongs to the group of B-species (van Dijk 1986).

The wing-dimorphic *melanocephalus* and the monomorph macropterous *mollis* were never caught flying, but laboratory-bred beetles of both species developed flight muscles and flew frequently in a laboratory test (to be published elsewhere). For the time being both species therefore have to be considered C-species. Den Boer (1977)

Table 13. Emergence of adult beetles in outdoor breeding experiments. N: number of beetles.

Year	Decade	SPECIES			N	(%)
		<i>cinctus</i>	<i>melanocephalus</i>	<i>mollis</i>		
1982	1-10 June	3	(1.8 %)	113	(43.3 %)	158
	11-20 June	136	(80.5 %)	101	(38.7 %)	2
	21-30 June	29	(17.2 %)	40	(15.3 %)	-
	1-10 July	1	(0.6 %)	7	(2.7 %)	-
1983	1-10 June	-	-	-	-	-
	11-20 June	69	(53.9 %)	12	(34.3 %)	32
	21-30 June	58	(45.3 %)	23	(65.7 %)	15
	1-10 July	1	(0.8 %)	-	-	-

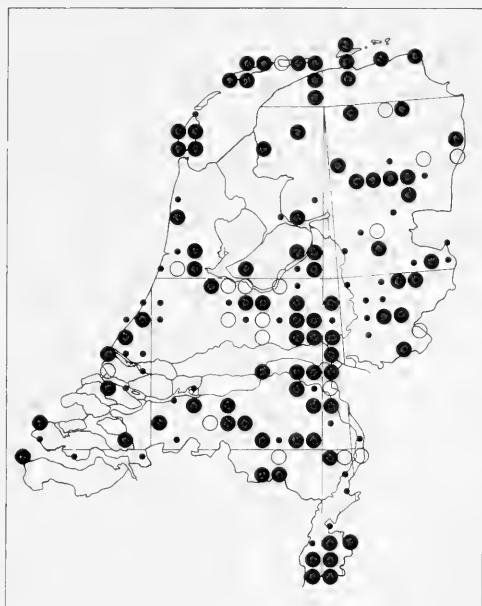


Fig. 16. Distribution of *Calathus melanocephalus* in The Netherlands.



Fig. 17. Distribution of *Calathus mollis* in The Netherlands.

and van Dijk (1986) treated *melanocephalus* as A-species, based on the extremely low frequency of macropterous beetles in populations investigated in the Dutch province of Drenthe (0.23%). Populations in the recently reclaimed Flevopolders, however, showed a considerable higher frequency of macropterous beetles (25-40%: den Boer 1970; Aukema 1986).

During breeding the flight muscles are autolysed in these species and flight only occurs before breeding. Data on the development of flight muscles and the occurrence of actual flight from the field and from breeding experiments in relation to temperature and availability of food will be treated elsewhere (Den Boer et al. (1980) already gave some preliminary data for *cinctus*).

Distribution

Distribution in The Netherlands

Available data were used to prepare distribution maps on the UTM 10 × 10 square km scale as used by the European Invertebrate Survey in The Netherlands (figs. 15-17).

Calathus cinctus (fig. 15) and *C. melanocephalus* (fig. 16) are widely distributed over the whole country, whereas *C. mollis* (fig. 17) is almost restricted to the coastal dune region, with only a few inland populations on blown sands or other large sand deposits. Desender (1985, 1986) and Moncel (1972)

published comparable maps and data for Belgium and France respectively.

A closer examination of the data of *cinctus* (fig. 15) shows, that this species has been caught regularly in The Netherlands since 1864 (Overveen, vi, 1 female, leg. J. Kinker, coll. Zoölogisch Museum, Amsterdam). For *melanocephalus* and *mollis* respectively the first records are Overveen, x.1864, J. Kinker, 1 male (coll. Zoölogisch Museum, Amsterdam) and Driebergen, 23.vii.1882, 1 male (coll. Zoölogisch Museum, Amsterdam).

Time-trends in the number of 10 × 10 km squares occupied per decade by the three species were estimated according to the method of Turin & den Boer (1988). Fig. 18 shows the time-trends after correction of the number of occupied squares for differences in collecting intensity between the decades (table 14). *Calathus melanocephalus* shows a significantly increasing time-trend, whereas both *cinctus* and *mollis* show rather indifferent time trends (fig. 18). When considering the 20th century only (table 14: decades 4-12) all three species show negative correlation coefficients, but only in the case of *cinctus* was this significant, largely due to the high number of squares occupied in the years 1910-1930.

Ranges

Concerning their general distribution, revision of material on a larger scale is necessary to get a

Table 14. Number of 10 x 10 km squares occupied per decade by *Calathus cinctus*, *C. melanocephalus* and *C. mollis*. TO: total number of squares occupied by all carabid species per decade; F: correction factor calculated from the total number of squares covering The Netherlands (F=448/TO); O: actual number of occupied squares; OF: corrected number of occupied squares (OF=O★F).

Decade	Nr	Years	TO	<i>cinctus</i>		<i>melanocephalus</i>		<i>mollis</i>	
				F	O	OF	O	OF	O
1	1	1870 - 1879	72	6.22	2	12	0	0	2
2	2	1880 - 1889	81	5.53	1	6	1	6	3
3	3	1890 - 1899	108	4.15	5	21	7	29	5
4	4	1900 - 1909	150	3.03	16	48	18	55	6
5	5	1910 - 1919	192	2.35	26	61	24	56	11
6	6	1920 - 1929	214	2.10	22	46	28	59	9
7	7	1930 - 1939	213	2.10	18	38	29	61	15
8	8	1940 - 1949	246	1.82	12	22	26	47	7
9	9	1950 - 1959	264	1.70	16	27	35	59	13
10	10	1960 - 1969	312	1.44	9	13	20	29	10
11	11	1970 - 1979	336	1.33	23	31	35	47	12
12	12	1980 - 1989	350 ¹⁾	1.28	21	27	33	42	9

¹⁾ Estimated value. Up till now 14714 records from 321 squares were recorded, but many have to be added (H. Turin, personal communication)

reliable picture (the data in Turin (1981) are only based on literature). In the Dutch collections mentioned and/or in the collections of the British Museum (Natural History), London, the Zoologisches Museum, Berlin, the Zoologische Staatssammlung, München, and M. Baehr, München, I have seen material from the following localities:

C. cinctus: South-England (south of the line River Seven -The Wash), Wales, Ireland, The Netherlands, Belgium, Germany, Poland, the Baltic States (Estonia), Russia, France, Spain, Sardinia, Corsica, Italy, Sicily, Malta, Yugoslavia, Austria, Hungary, Romania, Bulgaria, Albania, Greece, Cyprus, Turkey, Crimea, Ukraine, the Caucasus, Iran, Syria, Israel and Morocco;

C. melanocephalus: Finland, Sweden, Norway, Denmark, Iceland, England, Scotland, Wales, Ireland, The Netherlands, Belgium, Luxembourg, Germany, Poland, the Baltic States (Estonia), France, Spain, Sardinia, Corsica, Italy, Sicily, Yugoslavia, Switzerland, Austria, Hungary, Romania, Albania, Greece, Turkey, Ukraine and the Caucasus;

C. mollis: Denmark, England, Wales, Scotland, Ireland, The Netherlands, Belgium, Germany (the East Frisian Islands), France, Portugal, Spain, Majorca, Italy, Sicily, Yugoslavia, Greece, Turkey, Gibraltar, Malta, Algeria and Morocco.

Lindroth (1986) indicated the occurrence of *cinctus* in South-Sweden and Denmark (see also Bangsholt 1983) and of *mollis* in Norway. Since Lindroth listed the right combination of characters for both taxa, his findings, although not confirmed, are considered reliable. Anderson (1987, in litt. 1990) furthermore found *cinctus* to be sporadically distributed around the Irish coast south of the line from the Shannon Estuary to Dublin.

Calathus melanocephalus obviously has a Euro-

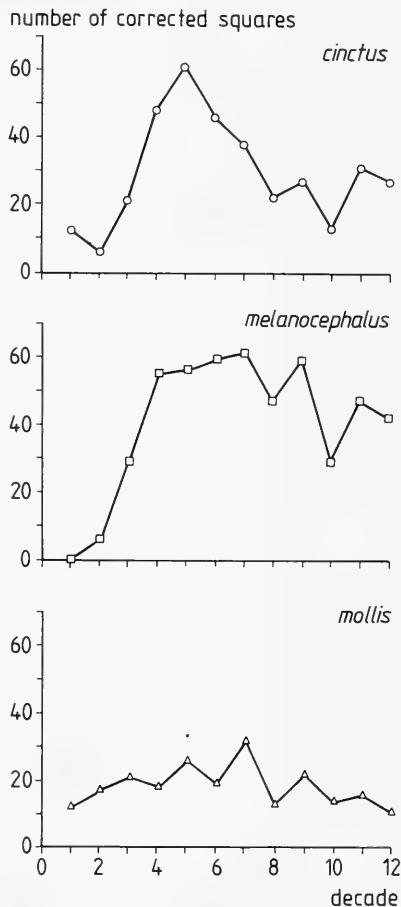


Fig. 18. Plots of the corrected time trends of *Calathus cinctus*, *C. melanocephalus* and *C. mollis*; decades: 1870-1879 (1), 1880-1889 (2), 1890-1899 (3), etc.

pean distribution, ranging from Iceland and Scandinavia in the North to the Mediterranean in the South. It is the only species of this group also occurring at higher altitudes in mountain areas. The subspecies *alpinus* Dejean is restricted to the eastern Alps (Koch 1989). Ball & Negre (1972) list a probably introduced specimen of *melanocephalus* from North America.

Calathus cinctus does not occur as far north as *melanocephalus*, but in the Mediterranean it reaches further south, occurring as far as Morocco and Algeria in the west and Syria and Iran in the east.

Calathus mollis seemingly is restricted to the Atlantic and Mediterranean coastal areas.

DISCUSSION

The establishment of *Calathus* (*Neocalathus*) *cinctus* as a good species has solved a major identification problem in the genus *Calathus*, although even now long winged females of *cinctus* are difficult to distinguish from those of *mollis*. On the other hand, a new problem arises in the interpretation of existing literature on the species of the *melanocephalus*-group. It is quite clear from the data presented here that *cinctus*, although in literature still considered to be mainly distributed in Eastern Europe (southeast and east of the river Weser) (Lienemann 1981; Koch 1989), is a very common species in Western Europe too. For instance in England *cinctus* was already present at the time of Stephens, because in his collection, bought in 1853 by the British Museum (Natural History), London, and kept in its original state (Hammond 1972) four out of the 13 specimens in the box of *melanocephalus* belong to *cinctus* (1 male and 3 females, all short winged). Furthermore Jeannel (1942) already indicated the occurrence of *cinctus* in western France (Vendée).

Lindroth (1949) used data on wing development in *Calathus mollis* as one of the main illustrations for his theory of postglacial recolonization of Fennoscandia. Although Lindroth indicated in the same publication that there were two taxa involved, his data were never revised. Also the data from the following studies will have to be reconsidered concerning species identity: for larval taxonomy

Table 15. Spearman rank correlation coefficients between the corrected number of squares occupied and the decade rank

Species	All decades	20th Century ¹⁾
<i>cinctus</i>	+0.21	-0.74*
<i>melanocephalus</i>	+0.72*	-0.54
<i>mollis</i>	-0.20	-0.60

*) 0.02 <P<0.05

¹⁾ decades 4-12 of table 14

(Kurka 1971: description of larval stages of *melanocephalus* and *mollis*), for diagnostics of eggs (Luff 1981: characteristics of the eggs of *melanocephalus* and *mollis*), for chromosome numbers (Serrano 1981: chromosome numbers of *melanocephalus* (n=37) and *mollis* (n=39)), for population dynamics (Gilbert 1956: population dynamics of *melanocephalus* and *mollis* in the coastal dunes of the Isle of Anglesey where, as we know now, all three species occur), for the occurrence in agricultural fields (Luff 1987: only references for the occurrence of *melanocephalus*), for flight observations (Palmén 1944: long-winged *melanocephalus* washed ashore on the southwestern coast of Finland; Honek & Pulpán 1983: *melanocephalus* caught in a light trap), and for bionomics and breeding (Kurka 1972: *melanocephalus* and *mollis*).

CONCLUSIONS

1. *Calathus* (*Neocalathus*) *cinctus* Gemminger & Harold is considered a good species, reproductively isolated from both the closely related *C.* (*N.*) *melanocephalus* (Linnaeus) and *C.* (*N.*) *mollis* (Marsham).
2. The species of this so-called *melanocephalus* group can be distinguished from each other reliably only on the basis of the shape of the elytra, coloration characters and the shape of the right parameres.
3. Morphological measurements and ratios are not useful in identifying these species.
4. Both *cinctus* and *melanocephalus* are wing-dimorphic with either fully developed wings (of about 1.5 times the length of the elytra) or reduced wings (of about 0.5 times the length of the elytra), whereas Dutch *mollis* always are macropterous.
5. According to the subdivision in habitat groups of Den Boer (1977) *cinctus* is classified as H-species (species preferring localities significantly influenced by human activities), *melanocephalus* as mainly a species of heath and peatmoor (F-species) and *mollis* as E-species (species of blown sands/dunes).
6. The species are night-active autumn breeders. *Calathus melanocephalus* reproduces earlier and during a shorter period in the season than *cinctus* and *mollis*.
7. Age-composition of populations of *cinctus* and *mollis* resembles those of *melanocephalus* (not only larvae, but also a varying part of the adult beetles overwinters and reproduces for a second time).
8. Concerning dispersal power *cinctus* is classified as a good disperser (B-species sensu Den Boer, 1977), whereas *melanocephalus* and *mollis* are considered C-species (species with uncertain

dispersal power) by lack of information on actual flight.

9. All three species are common in The Netherlands and were so during the 20th century. Both *cinctus* and *melanocephalus* are well distributed all over the country, whereas *mollis* is limited to coastal dunes and a few inland blown sands or other large sand deposits.
10. All three species are mainly european in distribution, with *melanocephalus* reaching further north and occurring also at higher altitudes in mountain areas, *cinctus* reaching further south and *mollis* limited to coastal areas in the Atlantic and mediterranean area.

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REFERENCES

Anderson, R., 1987. Some uncommon Carabidae (Coleoptera) from South Dublin/Wicklow. – Irish Naturalist Journal 22: 259-260.

Aukema, B., 1986. Wing length determination in relation to dispersal by flight in two wing dimorphic species of *Calathus* Bonelli (Coleoptera, Carabidae). – In: Carabid beetles. Their adaptations and dynamics (P. J. den Boer, M. L. Luff, D. Mossakowski and F. Weber eds.): 91-99. Fischer, New York.

Aukema, B., 1990. The nomenclature of the *melanocephalus* group of the genus *Calathus* (Coleoptera: Carabidae). – Entomologische Berichten, Amsterdam 50: 143-145.

Aukema, B. & M. L. Luff, 1990. *Carabus mollis* Marsham, 1802 (currently *Calathus mollis*; Insecta, Coleoptera): proposed conservation of the specific name. – Bulletin of Zoological Nomenclature 47, in press.

Baars, M. A. & Th. S. van Dijk, 1984. Population dynamics of two carabid beetles at a Dutch heathland II. Egg production and survival in relation to density. – Journal of Animal Ecology 53: 389-400.

Ball, G. E. & J. Negre, 1972. The taxonomy of the Nearctic species of the genus *Calathus* Bonelli (Coleoptera, Carabidae). – Transactions of the American Entomological Society 98: 413-533.

Bangsholt, F., 1983. Sandspringernes og løbebillerne udredelse og forekomst i Danmark ca. 1830-1981 (Coleoptera: Cicindelidae and Carabidae). – Dansk faunistisk Bibliotek 4: 1-271.

Boer, P. J. den, 1970. On the significance of dispersal power for populations of carabid-beetles (Coleoptera, Carabidae). – Oecologia 4: 1-28.

Boer, P. J. den, 1977. Dispersal power and survival. Carabids in a cultivated countryside. – Miscellaneous Papers Landbouwhogeschool Wageningen 14: 1-190.

Boer, P. J. den, T. H. P. van Huizen, W. den Boer-Daanje, B. Aukema & C. F. M. den Bieman, 1980. Wing polymorphism and dimorphism in ground beetles as stages in an evolutionary process (Coleoptera: Carabidae). – Entomologia Generalis 6: 107-134.

Desender, K., 1985. Carabid beetles new for the Belgian Fauna. – Bulletin et Annales de la Société (Royale) Entomologique de Belgique 121: 69-74.

Desender, K., 1986. Distribution and ecology of carabid beetles in Belgium (Coleoptera, Carabidae). 4. Species 153-217. – Studiedocumenten koninklijk Belgisch Instituut voor Natuurwetenschappen 30: 1-23.

DeZordo, I., 1979. Phänologie von Carabiden im Hochgebirge Tirols (Obergurgl, Österreich) (Insecta: Coleoptera). – Bericht Naturwissenschaftlich-Medizinischen Vereins Innsbruck 66: 73-83.

Dijk, Th. S. van, 1972. The significance of the diversity in age composition of *Calathus melanocephalus* L. (Col., Carabidae) in space and time at Schiermonnikoog. – Oecologia 10: 111-136.

Dijk, Th. S. van, 1973. The age-composition of populations of *Calathus melanocephalus* L. analysed by studying marked individuals kept in fenced sites. – Oecologia 12: 213-240.

Dijk, Th. S. van, 1978. *Calathus mollis erythroderus* Gemminger & Harald in Drenthe (Coleoptera, Carabidae). – Entomologische Berichten, Amsterdam 38: 151-153.

Dijk, Th. S. van, 1979a. On the relationship between reproduction, age and survival in two carabid beetles: *Calathus melanocephalus* L. and *Pterostichus coeruleocephalus* L. (Coleoptera, Carabidae). – Oecologia 40: 63-80.

Dijk, Th. S. van, 1979b. Reproduction of young and old females in two carabid beetles and the relationship between the number of eggs in the ovaries and the number of eggs laid. – In: P. J. den Boer, H.-U. Thiele & F. Weber (eds.). On the evolution of behaviour in carabid beetles – Miscellaneous Papers Landbouwhogeschool Wageningen 18: 167-183.

Dijk, Th. S. van, 1986. Changes in the carabid fauna of a previously agricultural field during the first twelve years of impoverishing treatments. – Netherlands Journal of Zoology 36: 413-437.

Forskåhl, B., 1972. The invertebrate fauna of the Kilpisjärvi area, Finnish Lapland. 9. Carabidae, with special notes on ecology and breeding biology. – Acta Societas Fauna Flora Fennica 80: 99-119.

Freude, H., 1976. Adephaga I. – Die Käfer Mitteleuropas 2: 1-302.

Friederichs, K., 1907. Über Verbreitung und Lebensweise einiger Käfer. – Archiv Freunde Naturgeschichte Mecklenburg 61: 48-60.

Gersdorf, E., 1937. Ökologisch-faunistische Untersuchungen über Carabiden der mecklenburgischen Landschaft. – Zoologische Jahrbücher für Systematik, Geographie und Biologie der Tiere 70: 17-86.

Gilbert, O., 1956. The natural histories of four species of *Calathus* (Coleoptera, Carabidae) living on sand dunes in Anglesey, North Wales. – Oikos 7: 22-46.

Hammond, P. M., 1972. On the type material of Staphylinidae (Col.) described by T. Marsham and J. F. Stephens. - *Entomologist's Gazette* 23: 129-135.

Hengeveld, R., 1980. Polyphagy, oligophagy and food specialization in ground beetles (Coleoptera, Carabidae). - *Netherlands Journal of Zoology* 30: 564-584.

Honek A. & J. Pulpán, 1983. The flight of Carabidae (Coleoptera) to light trap.- *Věstník československé Společnosti zoologické* 47: 13- 26.

Huizen, T. H. P. van, 1980. Species of Carabidae in which the occurrence of dispersal by flight of individuals has been shown. - *Entomologische Berichten*, Amsterdam 40: 167-168.

Jeannel, R., 1942. Coléoptères Carabiques. - *Faune de France* 40: 572- 1173.

Koch, K., 1989. Ökologie. I.- Die Käfer Mitteleuropas: 1- 440.

Kurka, A., 1971. Larvae of the Czechoslovak species of the genus *Calathus* Bonelli (Coleoptera, Carabidae). - *Acta entomologica bohemoslovaca* 68: 233-262.

Kurka, A., 1972. Bionomy of the Czechoslovak species of the genus *Calathus* Bon., with notes on their rearing (Coleoptera: Carabidae). - *Věstník československé Společnosti zoologické* 36: 101-114.

Lienemann, K., 1981. *Calathus erythroderus* Gemminger et Harold 1868 (Coleoptera, Carabidae) neu im Rheinland. - *Decheniana* 134: 176.

Lindroth, C. H., 1943. Zur Systematik fennoskandischer Carabiden. - *Entomologisk Tidskrift* 64: 1-68.

Lindroth, C. H., 1945. Die Fennoskandischen Carabidae. Eine tiergeografische Studie. 1. Spezieller Teil. - Göteborgs Kungliga vetenskaps- och vitterhetssamhälles Handlingar 6, Ser. B 4 (1): 1-709.

Lindroth, C. H., 1949. Die Fennoskandischen Carabidae. 3. Allgemeiner Teil. - Göteborgs Kungliga vetenskaps- och vitterhetssamhälles Handlingar 6, Ser. B 4 (3): 1-911.

Lindroth, C. H., 1974. Coleoptera, Carabidae. - Handbooks for the identification of British Insects 4 (2): 1- 148.

Lindroth, C. H., 1986. The Carabidae (Coleoptera) of Fennoscandia and Denmark. - *Fauna Entomologica Scandinavica* 15 (2): 233-497.

Luff, M. L., 1981. Diagnostic characters of the eggs of some Carabidae (Coleoptera). - *Entomologica scandinavicae*, Supplement 15: 317-327.

Luff, M. L., 1987. Biology of polyphagous ground beetles in agriculture. - *Agricultural Zoology Reviews* 2: 237- 278.

Melber, A., 1983. Calluna-Samen als Nahrungsquelle für Laufkäfer in einer nordwestdeutschen Sandheide (Col.: Carabidae). - *Zoologische Jahrbücher für Systematik* 110: 87-95.

Mols, P. J. M., Th. S. van Dijk & Y. Jongema, 1981. Two laboratory techniques to separate eggs of carabids from a substrate. - *Pedobiologia* 21: 444-445.

Moncel, J., 1972. A propos des *Calathus mollis* (Col. Carabidae) et de sa variété erythroderus. - *l'Entomologiste* 28: 26-30.

Palmén, E., 1944. Die anemohydrochore Ausbreitung der Insekten als zoogeographischer Faktor. - *Annales Zoologici Societas Zoologicae- Botanicae Fenniae*, Vänamo 10: 1-262.

Refseth, D., 1988. Annual pattern of activity, reproduction and development in some Norwegian Carabidae (Col.). - *Fauna norvegicae Ser. B* 35: 21-30.

Schatzmayr, A., 1937. I *Calathus d'Europa*. - *Publicationi del Museo Entomologico 'Pietro Rossi'* Duino 2: 1-50.

Serrano, J., 1981. Chromosome numbers and karyotypic evolution of Caraboidea. - *Genetica* 55: 51-60.

Skuhravý, V., 1959. Die Nahrung der Feldcarabiden. - *Acta Societas entomologicae ceskoslovenské* 56: 1-18.

Smit, H., 1957. Onderzoek naar het voedsel van *Calathus erratus* Sahlb. en *Calathus ambiguus* Payk. aan de hand van hun maaginhouden. - *Entomologische Berichten*, Amsterdam 17: 199-209.

Thiele, H.-U., 1977. Carabid beetles in their environments. A study on habitat selection by adaptations in physiology and behaviour: i-xvii, 1-369. - Berlin.

Turin, H., 1981. Provisional checklist of the European groundbeetles (Coleoptera: Cicindelidae & Carabidae). - *Monografieën Nederlandse entomologische Vereeniging* 9: 1-249.

Turin, H., J. Haeck & R. Hengeveld, 1977. Atlas of the carabid beetles of The Netherlands. - *Verhandelingen der Koninklijke Nederlandse Akademie van Wetenschappen*, afd. Natuurkunde (2) 68: 1-228.

Turin, H. & P. J. den Boer, 1988. Changes in the distribution of carabid beetles in The Netherlands since 1880. II. Isolation of habitats and long-term time trends in the occurrence of carabid species with different powers of dispersal (Coleoptera, Carabidae). - *Biological Conservation* 44: 179-200.

Vereshchagina, T. N., 1985. The genus *Calathus* Bon. (Coleoptera, Carabidae) in the USSR. - *Entomological Review* 63: 75-94.

Vlijm, L. & Th. S. van Dijk, 1967. Ecological studies on carabid beetles. II. General pattern of population structure in *Calathus melanocephalus* (Linn.) at Schiermonnikoog. - *Zeitschrift für Morphologie und Ökologie der Tiere* 58: 396-404.

Vlijm, L., Th. S. van Dijk & S. Y. Wijmans, 1968. Ecological studies on carabid beetles. III. Winter mortality in adult *Calathus melanocephalus* (Linn.). Egg production and locomotory activity of the populations which has hibernated. - *Oecologia* 1: 304-314.

Wiebes-Rijks, A. A., 1959. Het onderscheid tussen *Calathus melanocephalus* L. en *Calathus mollis* Marsh. (Coleoptera, Carabidae). - *Entomologische Berichten*, Amsterdam 19: 248-253.

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ANOMALAGRION HASTATUM (SAY), AN AMERICAN DAMSELFLY INDIGENOUS TO THE AZORES (ODONATA, COENAGRIONIDAE)

Belle, J. & J. van Tol, 1990. *Anomalagrion hastatum* (Say), an American damselfly indigenous to the Azores (Odonata, Coenagrionidae). – Tijdschrift voor Entomologie 133: 143-147, figs. 1-16. [ISSN 0040-7496]. Published 14 December 1990.

Anomalagrion hastatum (Say), a species hitherto known only from the New World, is recorded from the European archipelago of the Azores. It was captured for the first time on these islands in 1938, but was mistaken for *Ischnura senegalensis* (Rambur). Only females have been found up to now, and it is hypothesized, that this species reproduces parthenogenetically.

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Key words. – Azores; *Anomalagrion*; *Ischnura*; Europe; parthenogenetic reproduction.

In 1940 Valle published a paper on the Odonata of the Azores and Madeira, in which the occurrence of *Ischnura senegalensis* (Rambur) was reported for both the Azores and the Canary Islands. Belle (1982) examined the specimens in question from the Azores. He found that they were characterized by a very small vulvar spine and he expressed his doubts on the correctness of the identification, since the vulvar spine of *I. senegalensis* characteristically is very long (figs. 12, 15). His observations on the Canary Islands only revealed *Ischnura sabarensis* Aguesse, 1958. Hämäläinen (1986) could confirm Belle's supposition that Valle's identification for the individuals from the Canary Islands was incorrect. All specimens belonged, indeed, to *Ischnura saharenensis*.

The identity of the specimens of the Azores, however, remained uncertain due to the fact that only females were available. In the summer of 1988, the senior author decided to visit the Azores himself in order to trace the male of the misdetermined *Ischnura* species. He visited the Isles of São Miguel, São Jorge and Pico. On São Miguel and São Jorge, the desired species was not found, but on Pico more than 30 females were captured. Despite diligent hunting, the matching male was not encountered.

To unravel the status of the collected females, they then were handed over to the junior author for examination. After consultation of literature and the collection of the National Museum of Natural History, Leiden (RNHL), it soon became obvious, that they did not belong to one of the *Ischnura* species known from Europe or North Africa. They were referable to the closely related New World

genus *Anomalagrion*, and identified as *Anomalagrion hastatum* (Say). This identification was also shared by Drs. R. W. Garrison (Azusa, USA) and T. W. Donnelly (Binghamton, USA), who in collaboration examined three of the females.

***Anomalagrion hastatum* (Say, 1839) (Figs. 1-6, 11)**

Selected references

Agrion hastata Say, 1839: 38-39.

Ischnura (Anomalagrion) hastatum. – Selys 1876: sep. 11-13.

Anomalagrion hastatum. – Calvert 1901-1908: 130-131, 390; Garman 1927: 39-40, figs. 9-10, plate 2 (7); Walker 1953: 275-278, plate 11 (4), 21 (4), 26 (10), 30 (7).

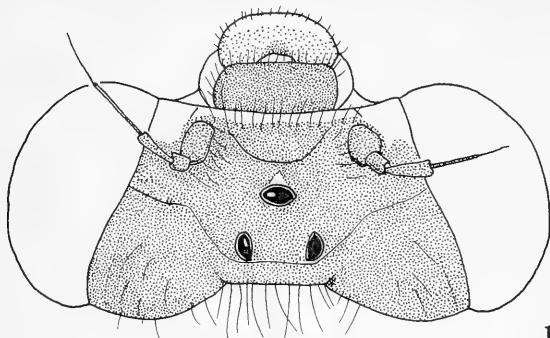
Ischnura senegalensis Rambur sensu Valle 1940: 2, 4 [misidentification].

Material

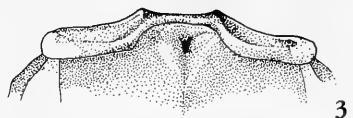
Azores. Pico: Lagoa do Caiado, 23 July 1988, 13 females; 26 July 1988, 12 females; Lagoa do Capitão, 24 July 1988, 7 females (J. Belle) in RNHL, but 3 specimens in coll. Garrison and one specimen in the collection of the University of Ghent. – Other material examined (all in RNHL): USA (Indiana, Texas, Georgia), Suriname, Galapagos Islands. Also the specimens mentioned by Valle (1940) have been examined.

Description

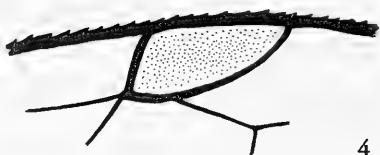
As indicated above, only females were collected. The material is remarkable homogeneous for a variable species as *Anomalagrion hastatum* appears to be in America. Although the specimens are relatively large for this species, they are very small for



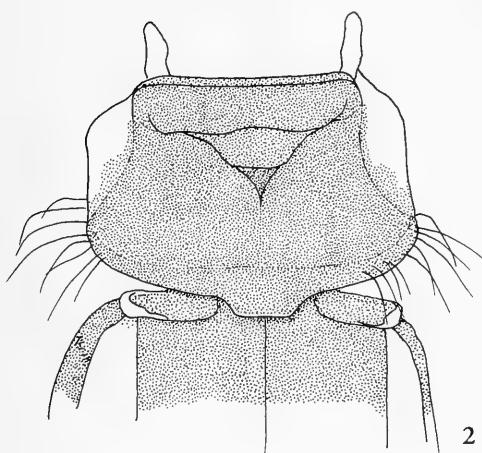
1



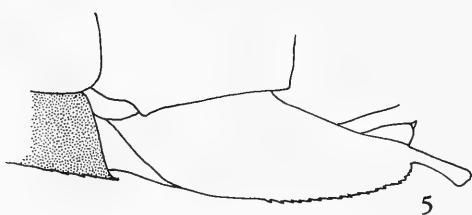
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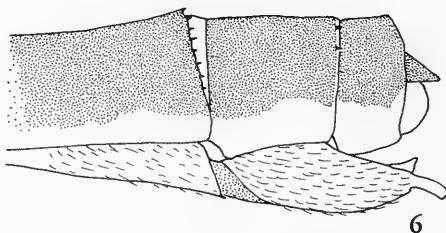
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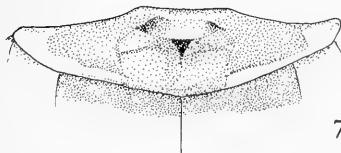
2



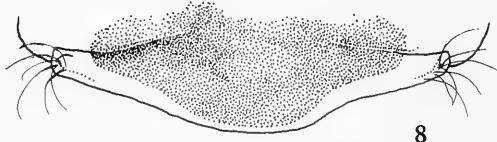
5



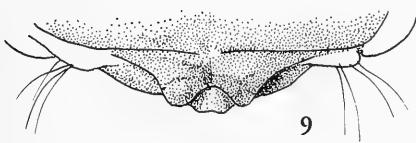
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7



8



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10

an European damselfly. They fall within the range of the smallest European species, *Nehalennia speciosa* (Charpentier). All specimens seem to be mature.

Head (fig. 1). — Labium creamish white, labrum light brown, medio-basally with a brownish black, triangular depression (not present in specimens from the New World, available in the RNHL collection); anteclypeus creamish white, postclypeus shiny black; frons and genae yellowish white; dorsum of head dull black, the posterior spots not or only just discernable, but hind margin of occiput bordered with a pale stripe, connecting the pale areas of the rear side of the head. Head covered with fragile, pale setae.

Thorax. — Prothorax (fig. 2) predominantly dull black, but sides yellowish white; hind margin simply built with a rectangular median projection. Synthorax with dorsal side black, but otherwise light brown and creamish. Humeral suture indicated in black. Mesostigmal laminae simply built (fig. 3) with a posterior ridge, rounded on lateral side. Lateral one-fourth of mesostigmal laminae pale coloured. Legs rather short, creamish white, but outer side of all femora black, and basal two-thirds of fore tibiae with a black stripe. Wings rather short, in rest approximately reaching the hind margin of segment 6; latero-posterior side of pterostigma (fig. 4) rounded with the two cross-veins behind it very close to each other.

Abdomen. — Dorsum of all segments rather dull black with some bluish of greenish shine and not interrupted on any segment, nor any trace of blue coloration, as e. g. in *Ischnura sabarensis*. Posterior part of segment 10 not conspicuously raised. Vulvar spine very small, hind margin of sternite 8 not elongated or otherwise produced posteriad (figs. 5-6).

COMPARISON WITH EUROPEAN SPECIES OF ISCHNURA

At least three palaearctic species of the genus *Ischnura* have to be considered for the archipelago, viz. *I. pumilio* (Charpentier), *I. senegalensis* and *Ischnura sabarensis* Aguesse. The first species is widespread in Europe, and not uncommon on the Azores (Valle 1940, observations by J. Belle), the second one was recorded from the Azores (Valle 1940) and from the Canary Islands (Valle 1955). However, all specimens of *Ischnura senegalensis*

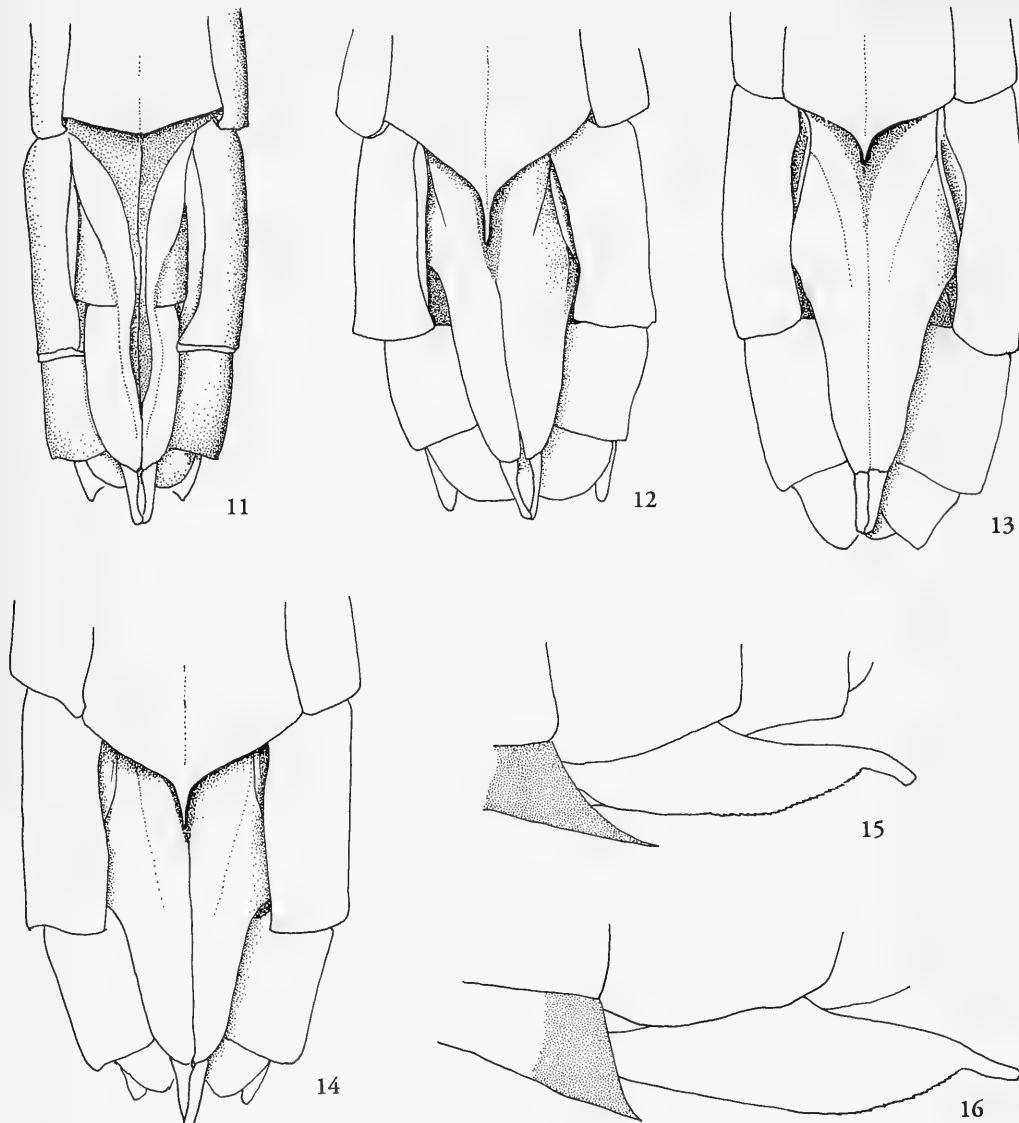
Figs. 1-10. — 1, *Anomalagrion hastatum* (Say), female from Pico, head, dorsal; 2, idem, prothorax, dorsal; 3, idem, laminae mesostigmatis; 4, idem, pterostigma; 5-6, idem, end of abdomen, left profile; 7, *Ischnura senegalensis* (Rambur), female from W. Java, laminae mesostigmatis; 8, Hind margin of prothorax of female, *Ischnura genei* (Rambur) from Sicilia; 9, idem, *I. pumilio* (Charpentier) from Pico; 10, idem, *I. sabarensis* Aguesse from Algeria.

recorded from the Canary Islands appeared to belong to *I. sabarensis* (Belle 1982, Hämäläinen 1986). We also found that specimens from the Azores identified as *I. senegalensis* by Valle evidently belonged to another taxon. Apart from these species already recorded from the atlantic islands, also the other species of *Ischnura* known from northern Africa and southern Europe, have to be taken into account, viz. *I. graellsii* (Rambur), a common species on the Iberian peninsula, *I. fontainei* Morton, a species known from northern Africa and the Middle East, and less likely also *I. elegans* (Vander Linden), the most common European species and *I. genei* (Rambur), known from Corsica, Sardinia, Sicilia and Malta.

Reliable characters for distinguishing females of *Ischnura* and related genera are found in the shape of the hind margin of the prothorax (figs. 8-10), the mesostigmal laminae (fig. 7), and the vulvar spine (figs. 11-16). In many species identification is hampered by the presence of two female forms, one similar to the male (homeomorphic) and one quite dissimilar (heteromorphic) form. This phenomenon was extensively described by Schmidt (1967).

The hind margin of the prothorax of *Ischnura* species is provided with two transversal ridges, which are developed in various ways in the European *Ischnura* species. *Ischnura senegalensis* males (and the homeomorphic females) have two subequal, parallel, unconnected ridges. Although this character is unique to *I. senegalensis*, it is somewhat confusing that the heteromorphic females are more like the species of the *I. elegans* group. The females pertaining to the *I. elegans* group (with *I. elegans*, *I. genei*, *I. graellsii* and *I. sabarensis*) can be recognized by the conformation of the raised hind margin of the prothorax having a longer or shorter anterior ridge developed into a protuberance. The raised part of the posterior ridge is most luxuriantly developed in *I. genei*, which also has a more or less incised protuberance on the anterior ridge (fig. 8). The protuberance is longer and the posterior ridge shorter in *I. elegans*, so that the protuberance of the anterior ridge almost fully covers the upraised part of the posterior ridge. The hind margin of the protuberance is usually more or less squarish (e.g. Geijskes & Van Tol 1983, fig. 121, Askew 1988, fig. 138), but female specimens from southern France tend to have a more incised hind margin of the protuberance. Although the ground plan of the prothorax of *I. sabarensis* is similar to that of *I. elegans*, the protuberance of the anterior ridge is hardly developed and the whole appearance is determined by the upraised hind margin of the posterior ridge (cf. Aguesse 1958, fig. 3).

The hind margin of the prothorax of females of *Anomalagrion* is quite dissimilar, since it is simply built without subparallel ridges. The males of *A.*



Figs. 11-16. – Abdomen of females in ventral (figs. 11-14) and left lateral (figs 15-16) view. – 11, *Anomalagrion hastatum* (Say) from Pico; 12, 15, *Ischnura senegalensis* from W. Java; 13, *Ischnura pumilio* (Charpentier) from the Azores; 14, *Ischnura graellsii* (Rambur) from Spain, Cádiz; 16, *Ischnura saharensis* Aguesse from Gran Canaria.

hastatum are absolutely unmistakable, since they are characterized by a pterostigma in the forewing that is retracted from the anterior margin of the wing. They also have a greatly enlarged cylindrical bifid process on the tergum of segment 10, but that character occurs in a less conspicuous form also in some North-American *Ischnura* species. The females of *A. hastatum* also differ in several characters from *Ischnura* species. The differential features were already described by de Selys (1876)... 'The females are more difficult to identify, since they have a normal pterostigma. They are, however,

quite easily distinguishable by the coloration of the head and the thorax, which are both similar to that in the male, by the spine of segment 8, which is much shorter than those in *Ischnura*, and, finally, on segments 8 and 9, which are black (which is exceptional in *Ischnura*)...'. He also mentions the existence of a orange coloured variety, which is the immature stage (Calvert 1907: 390).

Recently, a second species in the (sub)genus *Anomalagrion* was described (De Marmels 1987). Although the pterostigma of the male forewing of this species is greatly enlarged, it is not retracted

from the anterior margin of the wing. Attribution to the (sub)genus *Anomalagrion* should therefore be considered preliminary, awaiting a revision and phylogenetic analysis of *Ischnura* and related genera. Given the autapomorphies of *Anomalagrion hastatum*, a more than superficial analysis is needed to settle its position in the Coenagrionidae.

BIOLOGICAL OBSERVATIONS

It is most remarkable that no males were collected on the Azores up to now. The senior author spent in three days collecting many hours in the field without any result. We now hypothesize, that *Anomalagrion* is, at least on the Azores, a parthenogenetically reproducing species.

Several other characters support this hypothesis. Firstly, the morphology of the specimens of the Azores is very equal, while the specimens from localities wide apart in North and South America are quite dissimilar. This phenomenon can be understood for species with (partly) parthenogenetic reproduction, where there is no or hardly any gene-flow between populations, and specimens on one locality are the offspring of only one female. Secondly, it seems that in North America *Anomalagrion hastatum* is a species frequenting temporary or recently established habitats with females much more common than males. It is obvious that fully or partially parthenogenetic reproduction is advantageous to species of this kind of habitat, while also the likelihood to produce offspring after incidental transport by air to a remote island is significantly enlarged. Further biological studies are needed to test our hypothesis. As far as we know, there is no earlier record of parthenogenetic reproduction in Odonata.

The occurrence of an American dragonfly species on the Azores is consistent with the composition of the avifauna of these islands. There is a remarkably high percentage of American bird species among the migrant visitors. Den Hartog & Lavaleye (1981), for instance, could recognize four American species among the 23 species of non-breeding birds seen during a six weeks stay on six islands of the Azores (cf. Bannerman & Bannerman 1966).

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REFERENCES

Aguesse, P., 1958. Une sous-espèce nouvelle d'*Ischnura* en Afrique du Nord. – Revue française d'Entomologie 25: 149-157, figs. 1-5, map 1, tabs. 1-2.

Askev, R. R., 1988. The dragonflies of Europe. – Harley Books, Colchester: 1-291, figs. 1-502, plates 1-29.

Bannerman, D. A. & W. M. Bannerman, 1966. Birds of the Atlantic Islands. Volume 3. A history of the birds of the Azores. – Oliver & Boyd, London: i-xx + 1-262.

Belle, J., 1982. Odonata collected in the Canary Islands. – Entomologische Berichten, Amsterdam 42: 75-77.

Calvert, P. P., 1901-1908. Insecta. Neuroptera. Odonata. – Biologia Centrali Americana: i-xxx + 17-420 + plates 2-10.

De Marmels, J., 1987. *Ischnura (Anomalagrion) cruzi* sp. n., eine neue Kleinlibelle aus Kolumbien (Odonata: Coenagrionidae). – Mitteilungen der Entomologischen Gesellschaft Basel (N. F.) 37: 1-6, figs. 1-13.

Garman, P., 1927. Guide to the insects of Connecticut. Part V. The Odonata or dragonflies of Connecticut. – Bulletin of the State Geological and Natural History Survey, State of Connecticut 39: 1-331, figs. 1-67, plates 1-22 excl.

Geijskes, D. C. & J. van Tol, 1983. De libellen van Nederland (Odonata). – Koninklijke Nederlandse Natuurhistorische Vereniging, Hoogwoud: 1-368, figs. 1-539.

Hartog, J. C. den & M. S. S. Lavaleye, 1981. Birds observations in the Azores (12 September-1 November 1979). – Bocagiana 56: 1-19 + plates 1-8, tabs. 1-2.

Hämäläinen, M., 1986. Note on misidentification of the first Zygoptera material from the Canary Islands. – Notulae Odonatologicae 2: 131-132.

Peters, G., 1988. Libellen (Odonaten) von den Kanarischen Inseln. – Entomologische Nachrichten und Beiträge 32: 39-40.

Say, T., 1839. Descriptions of new North American neuropterous insects, and observations on some already described. – Journal of the Academy of Natural Sciences of Philadelphia 8: 9-46.

Schmidt, E., 1967. Versuch einer Analyse der *Ischnura elegans*-Gruppe (Odonata, Zygoptera). – Entomologisk Tidskrift 88: 188-225, figs. 1-2, tabs. 1-5, plates 1-7, 1 map.

Selys Longchamps, E. de, 1876. Synopsis des Agrionines, 5me légion: *Agrion* (suite). Le genre *Agrion*. – Bulletin de l'Académie royale de Belgique (series 2) 41/42: sep. 1-282.

Valle, K. J., 1940. Odonaten von den Azoren und Madeira. – Commentationes Biologicae 8 (5): 1-7.

Valle, K. J., 1955. Zygopteren (Odonata) von den Kanarischen Inseln. – Annales Zoologici Fennici 21: 182.

Walker, E. M., 1953. The Odonata of Canada and Alaska. Volume 1. – University of Toronto Press, Toronto: i-xi + 1-292, plates 1-44.

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CHIRONOMIDS OF THE RICE PADDY AREAS OF WEST BENGAL, INDIA (DIPTERA: CHIRONOMIDAE)

Chaudhuri, P. K. & S. Chattopadhyay, 1990. Chironomids of the rice paddy areas of West Bengal, India (Diptera: Chironomidae). – Tijdschrift voor Entomologie 133: 149-195, figs. 1-112, tabs. 1-3. [ISSN 0040-7496]. Published 14 December 1990.

Fiftythree species of Chironomidae are recorded for the first time from rice fields of West Bengal, India; 24 of these, including 5 new species, are new to India. *Cryptochironomus judicis* sp. n. is described from male imago, pupa and larva; *Harnischia tenuituberculata* sp. n., *Paracladopelma aratra* sp. n., *P. sacculifera* sp. n. and *Polypedilum circulum* sp. n. from male imagines. The male imago of *Stenochironomus longipalpis* (Kieffer) and all stages and both sexes of *Stictochironomus obscurus* (Guha & Chaudhuri) comb. n., *Clinotanypus fuscognatus* (Kieffer), and *Procladius noctivagus* (Kieffer) are redescribed. Keys for the identification of genera and species treated are presented for larvae, pupae and adults. A general account of biology, emergence patterns and sex ratios concludes this paper.

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Key words. – Chironomidae, rice fields, new species, keys, emergence, sex ratio.

Although rice fields have long been recognised as a pre-eminent habitat for chironomids, there are only few works dealing with this habitat. Thienemann (1954) listed the species of midges from rice fields of Southern Sumatra and West Java where the larvae were used as food of carp. The harmful activities of larvae of *Cricotopus trifasciatus* Panzer to the rice seedlings in France were discussed by Risbec (1952). Darby (1962) made a list of 36 species from rice fields and its vicinities of California (U.S.A.) and regarded 30 of them as actually inhabiting the rice paddies. Jones (1968) reported *Chironomus tepperi* Skuse as a pest of rice in Australia. Martin & Porter (1977) presented the biology of this species in the laboratory. Bognár (1958) included chironomids in the arthropod pest group of Hungary. Many chironomid species were reported to injure rice seedlings in Japan (Tokunaga & Kuroda 1935, 1936, Yokogi & Ueno 1971, Ishihara 1972). Hashimoto et al. (1981) gave a brief description of the adult morphology of 32 species of chironomids in the rice fields of Thailand. Sasa & Kikuchi (1986) made an account of 34 species from the rice fields of Japan and stated that at least 40 species of chironomids were found to be breeding in the rice paddy areas of Japan. There has been no previous attempt to give an account of chironomids of rice fields of the Indian subcontinent.

The present paper records 53 chironomid species from the rice paddies of West Bengal, India. Of these, 24 species, including 5 new species, are new

for India. A brief account of the biology, emergence patterns and sex ratios is also presented.

MATERIAL AND METHODS

Adults were collected by sweeping in the rice fields with a long handled insect net. Larvae were collected from bottom mud in the rice fields with the help of mud scrapers and a scoop sampler. Larvae were reared in petridishes in the laboratory following the procedure given by Chaudhuri et al. (1983). Unless otherwise mentioned, all specimens listed under 'Material examined' were collected in West Bengal by S. Chattopadhyay.

The phenol-balsam technique, as used by Das Gupta & Wirth (1968) was followed for microslide preparation of larvae, pupae and adults. Larval and pupal exuviae were also mounted on microslides in Gum-chloral solution (Sasa 1978) without dehydration. Morphological terminology essentially follows Saether (1980).

Measurements are given in millimeters (mm); the mean value is followed by the range and sample size (n) in parentheses.

The types, paratypes and other specimens of this study are provisionally kept in the insect collection of the Entomology Laboratory, Department of Zoology, University of Burdwan (B.U. Ent.), West Bengal, India, but will be deposited in the National Zoological Collections, Calcutta (NZC); National Pusa Collections, New Delhi; British Museum

(Natural History), London (BMNH); United States National Museum, Washington D.C. (USNM) and Zoologische Staatssammlung, München (FRG) in due course.

LIST OF CHIRONOMID SPECIES TREATED

Subfamily: Chironominae

Tribe: Chironomini

1. *Chironomus circumdatus* (Kieffer)
2. *Chironomus filitarsis* Kieffer
3. *Chironomus javanus* Kieffer
4. *Chironomus nudipes* Kieffer
5. *Chironomus samoensis* Edwards
6. *Chironomus striatipennis* Kieffer
7. *Cryptochironomus fulvus* (Johannsen)
8. *Cryptochironomus judicis* sp. n.
9. *Cryptochironomus rostratus* (Kieffer)
10. *Cryptochironomus subovatus* Freeman
11. *Dicrotendipes pelochloris* (Kieffer)
12. *Dicrotendipes septemmaculatus* (Becker)
13. *Endochironomus pekanus* (Kieffer)
14. *Harnischia acuta* (Goetghebuer)
15. *Harnischia incidata* Townes
16. *Harnischia tenuituberculata* sp. n.
17. *Harnischia viridula* (Linnaeus)
18. *Kiefferulus barbatitaris* (Kieffer)
19. *Kiefferulus calligaster* (Kieffer)
20. *Microchironomus fuscitarsus* (Guha & Chaudhuri)
21. *Microchironomus tener* (Kieffer)
22. *Paracladopelma aratra* sp. n.
23. *Paracladopelma sacculifera* sp. n.
24. *Pentapedilum robusticeps* Guha & Chaudhuri
25. *Pentapedilum uncinatum* (Goetghebuer)
26. *Polyepidium aegyptium* Kieffer
27. *Polyepidium annulatipes* (Kieffer)
28. *Polyepidium asicum* Chaudhuri, Guha & Das Gupta
29. *Polyepidium chaudhurri* Chaudhuri, Guha & Das Gupta
30. *Polyepidium circulum* sp. n.
31. *Polyepidium lineatum* Chaudhuri, Guha & Das Gupta
32. *Polyepidium nubifer* (Skuse)
33. *Polyepidium mediavittatum* Tokunaga
34. *Polyepidium suturalis* (Johannsen)
35. *Polyepidium yapensis* Tokunaga
36. *Stenochironomus bilaris* (Walker)
37. *Stenochironomus longipalpis* (Kieffer)
38. *Stictochironomus affinis* (Johannsen)
39. *Stictochironomus obscurus* (Guha & Chaudhuri) comb.n.
40. *Xenochironomus flaviventris* (Kieffer)

Tribe: Tanytarsini

41. *Cladotanytarsus conversus* (Johannsen)
42. *Cladotanytarsus gloveri* Ghosh & Chaudhuri
43. *Cladotanytarsus multispinulus* Guha, Das, Chaudhuri & Choudhuri
44. *Tanytarsus bifurcus* Freeman
45. *Tanytarsus commoni* Glover
46. *Tanytarsus fuscimarginalis* Chaudhuri, Guha & Ghosh
47. *Tanytarsus vinculus* Chaudhuri, Guha & Ghosh

Subfamily: Tanypodinae

48. *Clinotanypus fuscosignatus* (Kieffer)
49. *Procladius noctivagus* (Kieffer)

50. *Tanypus bilobatus* (Kieffer)
51. *Tanypus grandis* Chaudhuri, Das & Debnath
52. *Tanypus lucidus* Chaudhuri, Das & Debnath
53. *Tanypus tenebrosus* Chaudhuri, Das & Debnath

KEYS TO GENERA AND SPECIES

Larvae

Key 1. Chironomini – genera

1. Antenna 6 segmented *Stictochironomus* Kieffer (key 4)
- Antenna 5 segmented 2
2. Mentum with broad, pale untoothed central region *Cryptochironomus* Kieffer (species 7-10)
- Mentum without broad, pale untoothed central region 3
3. Ventral tubules present 4
- Ventral tubulus absent 5
4. Segment XI with 2 pairs of ventral tubules *Chironomus* Meigen (species 1-6)
- Segment XI with 1 pair of ventral tubules 6
5. S I blade-like. Mentum with a trifid median tooth and 6 pairs of lateral teeth *Microchironomus* Kieffer (key 3)
- S I plumose. Mentum with a bifid median tooth and 7 pairs of lateral teeth *Polypedilum* Kieffer (species 26-35)
6. Pecten epipharyngis with 5 teeth *Dicrotendipes* Kieffer (species 11, 12)
- Pecten epipharyngis with 16-19 teeth *Kiefferulus* Goetghebuer (key 2)

Key 2. *Kiefferulus* Goetghebuer

- S I pectinate. Ventromental plate with wrinkled outer surface. Posterior parapods each with 15-16 well-sclerotised claws 18. *barbatitaris* (Kieffer)
- S I plumose. Ventromental plate with smooth outer surface. Posterior parapods each with 13-14 claws 19. *calligaster* (Kieffer)

Key 3. *Microchironomus* Kieffer

- Mandible with pointed lateral teeth; seta interna with 3 main plumose branches; pecten mandibularis well developed. Ventromental plate wrinkled at its outer margin 20. *fuscitarsus* (Guha & Chaudhuri)
- Mandible with flat lateral teeth; seta interna with 3-4 filaments; pecten mandibularis absent. Ventromental plate smooth at its outer margin 21. *tener* (Kieffer)

Key 4. *Stictochironomus* Kieffer

- S I and S II leaf like; pecten epipharyngis comprised of 3 toothed plates, median one with 3 and each lateral one with 8 teeth 38. *obscurus* (Guha & Chaudhuri)
- S I and S II plumose; pecten epipharyngis comprised of 3 toothed plates, median one with 3-5 and each lateral one with 5 teeth 39. *affinis* (Johannsen)

Key 5. Tanypodinae – genera

- M appendage without pseudoradula *Tanypus* Meigen (species 50-53)
- M appendage with pseudoradula 2

2. Dorsosomal teeth not located on distinct plate. Mandible strongly hooked with large, pointed basal tooth. Ligula with 6 teeth *Clinotanypus* Kieffer (species 48)

- Dorsosomal teeth located on distinctly defined plate. Mandible not as above. Ligula with 5 teeth *Procladius* Skuse (species 49)

Pupae

Key 6. Chironomini – genera

1. Anal segment dorsally with forked, posteromedian process *Cryptochironomus* Kieffer (species 7-10)
- Anal point without such process 2
2. Segment VIII with 2 pair of simple caudolateral spurs, ending in a point 3
- Segment VIII with 1 pair of caudolateral spurs, each with more than 1 point 4
3. Thoracic horn with a bunch of finely branched filaments *Dicrotendipes* Kieffer (species 11, 12)
- Thoracic horn with 4 main bunches of finely branched filaments *Microchironomus* Kieffer (key 8)
4. Segment VI with only 3 pairs of filamentous lateral setae 5
- Segment VI with more than 3 pairs of filamentous lateral setae 6
5. Frontal setae short and slender *Polypedilum* Kieffer (species 26-35)
- Frontal setae long, robust and broad *Stictochironomus* Kieffer (key 9)
6. Tergite VII without median shagreen *Kiefferulus* Goetghebuer (key 7)
- Tergite VII with median shagreen *Chironomus* Meigen (species 1-6)

Key 7. *Kiefferulus* Goetghebuer

1. Thoracic horn with a bunch of fine filaments. Segment I with 1 pair of lateral setae, dorsal setae absent 18. *barbatitarsis* (Kieffer)
- Thoracic horn with 2 plumose branches. Segment I without lateral setae, dorsal setae 2 pairs 19. *calligaster* (Kieffer)

Key 8. *Microchironomus* Kieffer

1. Frontal seta absent. Tergite VII bare. Segments II-VIII with 1, 2, 2, 3, 4, 4, 2 pairs of dorsal setae. Segments V-VI without filamentous lateral setae 20. *fuscitarsus* (Guha & Chaudhuri)
- Frontal seta present. Tergite VII with subbasal transverse patches of shagreen. Segments II-VIII with 3, 6, 5, 4, 6, 6, 4 pairs of dorsal setae. Segments V-VI with filamentous alateral setae 21. *tener* (Kieffer)

Key 9. *Stictochironomus* Kieffer

1. Thoracic horn with a bunch of finely branched filaments, segment I without dorsal setae 36. *obscurus* (Guha & Chaudhuri)
- Thoracic horn with 2 main bunches of finely branched filaments, segment I with dorsal setae 37. *affinis* (Johannsen)

Key 10. Tanypodinae – genera

1. Thoracic horn without plastron plate *Tanypus* Meigen (species 50-53)

- Thoracic horn with plastron plate 2

2. Plastron plate reduced. Anal fin with a fringe of spines or spinules *Procladius* Skuse (species 49)

- Plastron plate broad. Anal fin without a fringe of spines or spinules *Clinotanypus* Kieffer (species 48)

Adults

Key 11. Chironomini – genera

1. Anal point with basolateral setaceous lobe *Microchironomus* Kieffer (key 17)
- Anal point without basolateral setaceous lobe 2
2. Posterior tibia with one spur 3
- Posterior tibia with two spurs 5
3. Macrotrichia present on wing membrane, wing without spots or markings *Pentapedilum* Kieffer (key 19)
- Macrotrichia absent on wing membrane, wing with or without spots or markings 4
4. Mesonotum with a distinct tubercle at the posterior end of the median vittae. Femora and tibiae usually ringed *Stictochironomus* Kieffer (key 22)
- Mesonotum without such tubercle at the posterior end of median vittae. Femora and tibiae not distinctly ringed *Polypedilum* Kieffer (key 20)
5. Inferior volsella reaching well beyond tip of gonocoxite and bearing long curved setae 6
- Inferior volsella not reaching beyond tip of gonocoxite and without long curved setae 11
6. Inferior volsella extremely broad and bulbous apically *Kiefferulus* Goetghebuer (key 16)
- Inferior volsella slender, not or scarcely enlarged distally 7
7. Inferior volsella strongly bowed dorsoventrally with an expanded clubbed or slightly to deeply bifid to trifid apex bearing many strong setae *Dicrotendipes* Kieffer (key 14)
- Inferior volsella not as above 8
8. Anal point very broad. Superior volsella short, broad and pubescent *Xenochironomus* Kieffer (species 40)
- Anal point narrow. Superior volsella not as above 9
9. Superior volsella strongly chitinized and bare except for a few long basal setae, usually ending a spur or hook *Chironomus* Meigen (key 127)
- Superior volsella not as above 10
10. Antepronotum extending to anterior edge of scutum but deeply divided into two anterior lobes. Inferior volsella slender bearing 2 long apical setae and without terminal spine *Endochironomus* Kieffer (species 13)
- Antepronotum not as above. Inferior volsella very long bearing no apical setae but with a well differentiated terminal spine *Stenochironomus* Kieffer (key 21)
11. Superior volsella short and broad, densely pubescent with a few long setae. Inferior volsella in the form of a small pubescent pad *Paracladopelma* Harnisch (key 18)
- Both volsellae not as above 12

12. Gonostylus short and broad. Superior volsella short, broad and pubescent *Cryptochironomus* Kieffer (key 13)
 - Gonostylus longer. Superior volsella reduced, occasionally absent *Harnischia* Kieffer (key 15)

Key 12. *Chironomus* Meigen

1. Wing with spots or markings 6. *striatipennis* Kieffer
 - Wing without spots or markings 2
 2. Antepronotals 2. Scutellum with 8 setae 3. *javanus* Kieffer
 - Antepronotals absent. Scutellum with more than 17 setae 3
 3. Corona with 2 setae. Gonostylus oblong with blunt apex 4. *nudipes* Kieffer
 - Corona bare. Gonostylus not as above 4
 4. Branchiolum with 3 setae. Haltere setose 5. *samoensis* Kieffer
 - Branchiolum with 2 setae. Haltere bare 5
 5. Tergites II-V with grey, oval median spots 1. *circundatus* (Kieffer)
 - Tergites II-IV with brown, square median spots 2. *filitarsis* Kieffer

Key 13. *Cryptochironomus* Kieffer (males)

1. Scutellum with 6-10 setae 2
 - Scutellum with 17-26 setae 3
 2. Frontal tubercles prominent and each with an apical knob. Superior volsella more or less globular, inferior volsella small and superposed on superior volsella 7. *fulvus* (Johannsen)
 - Frontal tubercles small, rounded and each without an apical knob. Superior volsella short, digitiform; inferior volsella absent 10. *subovatus* Freeman
 3. Haltere light yellow with 11-13 setae. Superior volsella cone shaped bearing 2 setae, inferior volsella absent 8. *judicius* sp. n.
 - Haltere yellowish green and bare. Superior volsella thumblike bearing 3 apical setae, inferior volsella present 9. *rostratus* (Kieffer)

Key 14. *Dicrotendipes* Kieffer (males)

1. Scutellum with 6-8 setae in one transverse row. Wing without spots. Inferior volsella gently bowed ventrally 11. *pelocholoris* (Kieffer)
 - Scutellum with 12 setae in two transverse rows. Wing with 6 grey spots. Inferior volsella bifurcated into 2 blunt lobes 12. *septemmaculatus* (Becker)

Key 15. *Harnischia* Kieffer (males)

1. Male hypopygium without well marked gonocoxite and gonostylus 17. *viridula* (Linnaeus)
 - Male hypopygium with well marked gonocoxite and gonostylus 2
 2. Haltere bare 16. *tenuituberculata* sp. n.
 - Haltere setose 3
 3. Branchiolum with 2 setae. Superior volsella bearing 3 long apical setae, inferior volsella rudimentary without long setae 14. *acuta* (Goetghebuer)
 - Branchiolum with 1 seta. Superior volsella bearing 1 apical seta, inferior volsella absent 15. *incidata* Townes

Key 16. *Kiefferulus* Goetghebuer (males)

1. Scutellum with 20 setae in two transverse rows. Branchiolum with 4 setae. Anal point well developed, tongue like 18. *barbatiaris* (Kieffer)
 - Scutellum with 6 setae in one transverse row. Branchiolum with 2 setae. Anal point dark, more or less peggish 19. *calligaster* (Kieffer)

Key 17. *Microchironomus* Kieffer (males)

1. Anal point with a small setaceous basolateral lobe. Gonostylus with 15-17 setae at its inner margin. Superior volsella little curved with 1 apical seta 20. *fuscitarsis* (Guha & Chaudhuri)
 - Anal point with a large setaceous basolateral lobe. Gonostylus with 8-10 setae at its inner margin. Superior volsella long and slender with 2-3 apical spine 21. *tener* (Kieffer)

Key 18. *Paracladopelma* Harnisch (males)

1. Frontal tubercles absent. Prescutellar present. Spurs of hind tibia equal. Anal point tubular 22. *aratra* sp. n.
 - Frontal tubercles present. Prescutellar absent. Spurs of hind tibia unequal. Anal point with saccular tip 23. *sacculifera* sp. n.

Key 19. *Pentapedilum* Kieffer

1. Scutellum with 26 setae in two transverse rows. Branchiolum with 7 setae. Anal point robust, superior volsella without lateral 24. *robusticeps* Guha & Chaudhuri
 - Scutellum with 10-11 setae in a transverse row. Branchiolum with 1 seta. Anal point rod like, rather pointed at tip, superior volsella with 1 lateral seta 25. *uncinatum* (Goetghebuer)

Key 20. *Polypedilum* Kieffer (males)

1. Wing with spots or markings 2
 - Wing without spots or markings 6
 2. AR less than 1 31. *lineatum* Chaudhuri et al.
 - AR more than 1 3
 3. Frontal tubercles present 32. *nubifer* (Skuse)
 - Frontal tubercles absent 4
 4. Anal point narrow with pointed apex 27. *annulatipes* (Kieffer)
 - Anal point broad without pointed apex 5
 5. Prealars 3. Scutellum with a row of setae 26. *aegyptium* Kieffer
 - Prealars 6. Scutellum with 2 rows of setae 29. *chaudhuri* Chaudhuri et al.
 6. Haltere setose 7
 - Haltere bare 8
 7. Superior volsella curved with blunt tip and 1 long lateral seta near the base 30. *circulum* sp. n.
 - Superior volsella scimitar-like without lateral seta 33. *medivittatum* Tokunaga
 8. Superior volsella without lateral seta 28. *ascium* Chaudhuri et al.
 - Superior volsella with lateral seta 9
 9. Prescutellar present, scutellum with 6 setae. Tergites I-VII with brown median band 34. *suturalis* (Johannsen)
 - Prescutellar absent, scutellum with 4 setae. Tergites uniformly brown 35. *yapensis* Tokunaga

Key 21. *Stenochironomus* Kieffer (males)

1. Scutellum with 30 setae in two transverse rows. Wing with pale median and apical bands 36. *bilaris* (Walker)
- Scutellum with 14 setae in one transverse row. Wing unmarked 37. *longipalpis* (Kieffer)

Key 22. *Stictochironomus* Kieffer (males)

1. Corona with 4 setae. Anal point with an apical knob 39. *obscurus* (Guha & Chaudhuri)
- Corona bare. Anal point without apical knob 38. *affinis* (Johannsen)

Key 23. *Tanytarsini* - genera

1. Median volsella long and branched *Cladotanytarsus* Kieffer (key 24)
- Median volsella short and brush-like *Tanytarsus* v. d. Wulp (key 25)

Key 24. *Cladotanytarsus* Kieffer (males)

1. Frontal tubercles absent 43. *multispinulus* Guha et al.
- Frontal tubercles present 2
2. Anal point inverted 'bell-shaped' and with 6-8 punctures 42. *gloveri* Ghosh & Chaudhuri
- Anal point short without punctures 41. *conversus* (Johannsen)

Key 25. *Tanytarsus* v. d. Wulp (males)

1. Anal point bifurcated 44. *bifucus* Freeman
- Anal point simple 2
2. Brachiolum with 2 setae 46. *fuscimarginalis* Chaudhuri et al.
- Brachiolum with 1 seta 3
3. Scutellum with 6 setae. Anal point with 4 lateral setae and a subapical oval lobe 45. *commoni* Glover
- Scutellum with 4 setae. Anal point without lateral setae and subapical oval lobe 47. *vinculus* Chaudhuri et al.

Key 26. *Tanypodinae* - genera

1. Fourth tarsal segment bilobed and shorter than fifth *Clinotanypus* Kieffer (species 48)
- Fourth tarsal segment cylindrical and not shorter than fifth 2
2. Distance between FCu and MCu less than one third the length of Cu₁ *Tanypus* Meigen (key 27)
- Distance between FCu and MCu at least half the length of Cu₁ *Procladius* Skuse (species 49)

Key 27. *Tanypus* Meigen (males)

1. Brachiolum with 1 seta 2
- Brachiolum with 2 setae 3
2. Scutellum with 10 large setae at the posterior border and 20-22 small setae arranged in the anterior region 52. *lucidus* Chaudhuri et al.
- Scutellum with 6-10 setae at the posterior region 50. *bilobatus* (Kieffer)
3. Tarsomeres I-IV with apical dark brown bands, tarsomere V brown 51. *grandis* Chaudhuri et al.
- Tarsomeres uniformly brown 53. *tenebrosus* Chaudhuri et al.

SYSTEMATIC ACCOUNT**1. *Chironomus circumdatus* (Kieffer)***Tendipes circumdatus* Kieffer, 1916: 110.*Chironomus circumdatus*; Hashimoto 1977: 83; Sasa 1978: 11; Hashimoto et al. 1981: 5; Sasa & Hasegawa 1983: 316; Sasa & Kikuchi 1986: 18.

Material examined. - 11 ♂, Howrah, 4 September 1987; 6 ♂, Haldia, 16 October 1987; 4 ♂, Burdwan, 7 September 1987.

Distribution. - Japan, Korea, Taiwan, Thailand and India (present record).

Differential diagnosis. - i) scutellum with 24-26 setae, ii) abdominal tergites I-V each with grey oval median spot, iii) a deep constriction between segments VII and VIII and iv) hypopygium with stout anal point and superior volsella slightly curved.

2. *Chironomus filitarsis* Kieffer*Chironomus filitarsis* Kieffer, 1911: 160; Chaudhuri & Guha 1987: 27.

Material examined. - 6 ♂, Burdwan, 30 May 1986.

Distribution. - India.

Differential diagnosis. - i) scutellum with 22-24 setae, ii) fore tibial scale blunt, bearing 2 long setae, iii) tergites II-IV each with square shaped dark brown spot and iv) superior volsella bent inward with pointed apex.

3. *Chironomus javanus* Kieffer*Chironomus javanus* Kieffer, 1924b: 263; Johannsen 1932: 536; Tokunaga 1964: 566; Hashimoto et al. 1981: 7; Sasa & Hasegawa 1983: 317; Sasa & Kikuchi 1986: 18.

Material examined. - 6 ♂, Farakka, 29 September 1986; 9 ♂, Howrah, 4 September 1987.

Distribution. - Caroline Islands, Japan, Java, Marshall Islands, Thailand and India (present record).

Differential diagnosis. - i) antepronotum bearing 2 antepronotals, ii) supraalars absent, iii) fore tibial scale bearing 4 long setae, iv) tarsomeres I-III brown at apex, tarsomeres IV-V dark brown and v) hypopygium with long and tubular anal point, gonostylus with swollen basal half and superior volsella curved.

Remarks. - The specimens collected from the rice fields conform fully with those described by Hashimoto et al. (1981) and Sasa & Hasegawa (1983), except minor morphometrical differences.

4. *Chironomus nudipes* Kieffer

Chironomus nudipes Kieffer, 1911: 164; Chaudhuri & Guha 1987: 27.

Material examined. – 6 ♂, Uttarpara, 9 September 1987.

Distribution. – India.

Differential diagnosis. – i) fore tibial scale with 2 long setae, ii) tarsomeres III-V brown, iii) tergites VI-VII each with dark brown median spot and iv) hypopygium with stout, arrow shaped anal point, gonostylus oblong with blunt apex, superior volsella bow-shaped and inferior volsella curved.

5. *Chironomus samoensis* Edwards

Chironomus samoensis Edwards, 1928: 67; Tokunaga 1964: 567; Hashimoto 1977: 82; Sasa & Hasegawa 1983: 316; Sasa & Kikuchi 1986: 18.

Chironomus dorsalis Tokunaga, 1940a: 220 (see Tokunaga 1964).

Chironomus eximius Johannsen, 1946: 193 (see Tokunaga 1964).

Chironomus flaviplumus Tokunaga, 1940b: 294; Sasa 1978: 12; Ree & Kim 1981: 136.

Material examined. – 8 larvae, Berhampur, 2 January 1988; 4 larvae, 12 ♂ and 12 ♀ pupae, 5 ♂ and 7 ♀ exuviae, 10 ♂ and 10 ♀, all reared.

Distribution. – Caroline Islands, Japan, Java, Korea, Marshall Islands, Samoa, S. Mariana Islands and India (present record).

Differential diagnosis. – Larva: i) sickle shaped S I, ii) pecten epipharyngis with 14 teeth, iii) premandible with 2 unequal apical teeth, premandibular brush short, iv) mandible with 2 seta externa, v) bladelike anterior chaeta of maxilla and vi) Xth abdominal segment with apically pointed caudolateral processes.

Pupa: i) cephalic tubercles conical, bearing subapical setae, ii) thoracic horn with a bunch of finely branched filaments, iii) pedes spurii A present caudolaterally on segment IV-VII, iv) segment I-VIII with 4, 5, 3, 4, 3, 4, 6, 2 pairs of dorsal setae and 1, 3, 3, 3, 4, 4, 4, 5 pairs of lateral setae, v) caudolateral spur on segment VIII with 2-4 unequal points or branches, vi) G/F 0.66 in male and 0.76 in female.

Adult: i) frontal tubercles well developed, ii) prescutellar present, scutellars in two transverse row, iii) brachiolum with 3 setae, iv) RM and FCu almost in the same line, v) colour pattern of legs, vi) tergites II-VI with grey median spots in male, vii) superior volsella of male hypopygium shoe shaped, inferior volsella with 13-15 apically bifid or trifid setae and viii) genitalia of female with prominent apodeme lobe.

6. *Chironomus striatipennis* Kieffer

Chironomus striatipennis Kieffer, 1910: 236; Chaudhuri & Guha 1987: 27.

Material examined. – 6 ♂, Palasi, 18 August 1986; 3 ♂, Uttarpara, 24 February 1987; 8 ♂, Burdwan, 6 September 1987.

Distribution. – India and Taiwan.

Differential diagnosis. – i) scutellum with 14-18 setae, ii) markings in wings, iii) tarsomeres I-III dark brown at apices, iv) tergites II-V with brown median spots and v) hypopygium with bent anal point and curved superior volsella.

7. *Cryptochironomus fulvus* (Johannsen)

Chironomus fulvus Johannsen, 1905: 224.

Chironomus (*Cryptochironomus*) *fulvus*; Johannsen 1937: 39.

Tendipes (*Cryptochironomus*) *fulvus*; Darby 1962: 50.

Cryptochironomus fulvus (Johannsen); Townes 1945: 98; Hashimoto et al. 1981: 16; Sasa & Hasegawa 1983: 322; Sasa & Kikuchi 1986: 20.

Material examined. – 5 ♂, Berhampur, 17 August, 1986.

Distribution. – Japan, Thailand, U.S.A. and India (present record).

Differential diagnosis. – i) frontal tubercles prominent and each with an apical knob, ii) anterpronotum reduced, iii) scutellum with 10 irregular setae, iv) gonocoxite and gonostylus ankylosed, v) superior volsella semiglobular, finely setose and with 3 long setae and vi) inferior volsella small, superposed on superior volsella bearing one apical seta.

8. *Cryptochironomus judicius* sp. n.

Type material. – Holotype ♂, India, West Bengal, Uttarpara, 9 September 1987, leg. S. Chattopadhyay (Type no. 182 B.U. Ent.). Paratypes: 4 ♂, data as holotype; 5 ♂, 8 pupae and 8 exuviae, 6 larvae and 4 exuviae, all reared in laboratory.

Differential diagnosis. – Larva: i) AR 0.96, ii) S I and S II blade like, iii) premandible with 4 unequal apical teeth, premandibular brush dense, short, iv) pecten mandibularis absent, v) each lateral comb of mentum with 7 dark pointed teeth; 7th tooth minute, vi) maxilla with 2 sensilla basiconica and vii) procerus with 8 anal setae.

Pupa: i) cephalic tubercles elevated and bearing subapical setae, ii) thoracic horn with an oval base and finely branched filaments, iii) pedes spurii A caudolateral on segment IV and pedes spurii B basolateral on segment I, iv) tergite I bare, v) lateral setae on segments VI-VIII filamentous and vi) caudolateral spur on segment VIII with 4-5 stout spines.

Adult: i) frontal tubercles very small, ii) scutel-

lum with 26 irregular setae, iii) haltere light yellow with 11-13 setae, iv) fore tibia with a blunt scale bearing 3 long setae, v) colour pattern of tergomeres, vi) pulvilli moderately developed, vii) tergites II-VI with grey caudal spots, viii) gonostylus dark brown and ix) superior volsella cone shaped bearing 2 setae.

Remarks. – The species is named *judicius* for its pointed teeth of the lateral combs of the larval mentum. The present species resembles *C. neonilicola* Kieffer as described by McLachlan (1969) in respect to the larval antennal characteristics. It shares similarities in the mandible with *C. lindneri* Freeman, *C. diceras* Kieffer and *C. conus* Mason, 1985, in the ventromental plate with *C. ramus* Mason, 1985 and in mentum and maxilla with *C. eminentia* Mason. The pupal respiratory organ of *C. redekei* (Kruseman) appears to be similar to that of the present species. The adults of the new species look like *C. conus* Mason in the shape and structure of the anal point of the male hypopygium.

Description

Adult. – Male: Body 3.98 (3.91-4.13, n = 9) long, wing 1.47 (1.44-1.48, n = 10) long and 0.46 (0.45-0.48, n = 10) wide.

Head: Brown. Vertex with 8-11 setae (IV 2-3, OV 5-6, PO 1-2). Corona bare. Clypeus with 23-25 setae, clypeal ratio 1:1. Maxillary palp pale brown, ratio of palpalomere length I-V: 9 : 14 : 38 : 33 : 52; L/W. 4.75. Frontal tubercles (fig. 1) small. Antenna brown, ratio of flagellomere length I-XI: 17 : 7 : 8 : 6 : 6 : 6 : 6 : 6 : 5 : 254; AR 3.36; pedicel ratio 0.94. CA 0.57; CP 1.24.

Thorax: Yellow: Antepronotum collar-like with slight emargination in the middle, antepronotals O. Mesonotum with 3 brown vittae. Acrostichals 24-25 irregularly biserial, dorsocentrals 17 uniserial, humerals 5, prealars 5. Scutellum with 26 irregular setae, postscutellum dark brown and bare. Wing (fig. 2): Hyaline. Brachiolum with 2 setae and 19-21 sensilla campaniformia. R with 24, R_1 with 11-12 and R_{4+5} with 26-28 setae; R_{2+3} meets C at a distance of 0.14 from R_1 ; RM and FCu almost in same line. An ends below FCu. Squama with 12-13 setae. Haltere light yellow with 11-13 setae. CR 0.89; VR 1.12.

Legs: Yellow. Fore tibia with a blunt scale (fig. 3) bearing 3 long setae. Spurs of mid tibia subequal, 0.021 and 0.018 long, ratio of length of spurs to the apical diameter of mid tibia 7 : 15 and 6 : 15; spurs of hind tibia unequal 0.024 and 0.018 long, ratio of length of spurs to the apical diameter of hind tibia 8 : 18 and 6 : 18. Apex of tarsomeres I-III, tarsomeres IV-V of fore leg and tarsomere V of mid and hind legs brown, sensilla chaetica indistinguishable. Pulvilli moderately developed. Proportions and ratios of leg-segments in table 1.

Abdomen: Yellow. Tergites II-VI (fig. 4) with grey caudal spots. Hypopygium (fig. 5) with slender anal point 0.057 long bearing 7-8 basolateral setae. Gonocoxite with 5-6 setae; gonostylus stout, dark and with 8-9 setae at its inner margin and 8-10 setae over it. Superior volsella cone shaped bearing 2 setae; inferior volsella absent. Transverse sternapodeme 0.033, lateral sternapodeme 0.147, coxapodeme 0.057 and phallapodeme 0.12 long. HR 0.39; HV 1.89.

Female. – Unknown.

Pupa. – Reddish brown. Exuviae pale brown. Body 5.19 (5.17-5.24, n = 8) long in male. Female pupa and exuviae unknown.

Cephalothorax: Brown. Frontal apotome (fig. 6) with elevated cephalic tubercles, 0.02 long and 0.048 diameter at base, subapical faint frontal seta 0.027 long. Antennal sheath in ♂ (fig. 7) 0.72 long. Thorax rugose; wing sheath 0.99 long; Thoracic horn (fig. 8) with oval base 0.051 wide and a bunch of finely branched filaments. 2 pairs of precorneal setae.

Abdomen (fig. 9): Pale brown. Pedes spurii A caudolateral on segment IV, pedes spurii B basolateral on segment I. Tergite 1 bare; tergite II (fig. 10) with median patch of shagreen and with a caudal row of numerous hooklets; tergites III-IV with subbasal transverse patch of shagreen; tergites V-VI with shagreen in the form of inverted 'T'; tergite VII with median longitudinal and tergite VIII with subbasal patch of shagreen. Segments II-VIII with 3, 4, 4, 4, 3, 4, 2 pairs of dorsal setae and segments II-VIII with 2, 2, 2, 4, 4, 4, 5 pairs of lateral setae, on segments VI-VIII filamentous; segment VIII with 1 pair of caudolateral spur 0.024 long, each with 4-5 stout spines. Anal fin (fig. 9) 0.31 long with forked processes and numerous filamentous setae. Genital sac in ♂ (fig. 11) 0.35 long. G/F 1.12 in ♂.

Fourth instar larva. – Colouration red, exuviae white, head capsule, claws of anterior and posterior parapods, and anal setae brown. Body 7.97 (7.64-8.09, n = 10) long.

Head: Brown. Occipital margin light brown. Ventral head capsule (fig. 12) 0.35 long and 0.29 wide. Two eye spots connected to each other. Antenna (fig. 13) five-segmented, basal antennal segment 0.036 long and 0.013 wide, with a ring organ 0.006 in diameter, distance to ring organ from base 0.024; blade of basal antennal segment 0.03 long; accessory blade 0.021 long; blade of antennal segment II 0.013 long; Lauterborn organ small, at apex of antennal segment III; ratio of antennal segment length I-V: 12 : 4.5 : 6 : 1 : 1; AR 0.96. Labral lamella unmarked; SI (fig. 14) blade like 0.093 long, between the bases of two SI 0.018 long; S II blade

Table 1. Proportions and ratios of leg-segments of adult Chironomidae.

	Fe	Ti	ta1	ta2	ta3	ta4	ta5	LR	BV	SV	BR
8. <i>Cryptochironomus judicius</i> sp.n.											
Fore	54	46	71	36	27	21	11	1.54	1.80	1.69	2.14
Mid	49	45	29	14	10	6	5	0.64	3.51	4.48	2.4
Hind	56	57	45	21	19	11	7	0.79	2.72	3.05	2.7
16. <i>Harnischia tenuituberculata</i> sp.n.											
Fore	37	24	49	28	20	14	8	2.04	1.57	1.17	2.80
Mid	33	29	17	11	6	4	3	0.59	3.29	4.77	3.20
Hind	42	44	28	17	15	8	3	0.64	2.53	3.07	4.43
22. <i>Paracladopelma aratra</i> sp.n.											
Fore	31	21	37	19	15	10	6	1.76	1.78	1.68	2.5
Mid	29	23	12	6	4	3	2.5	0.52	4.13	5.47	2.8
Hind	32	31	19	11	10	5	4	0.61	2.56	3.31	3.2
23. <i>Paracladopelma sacculifera</i> sp.n.											
Fore	49	30	67	31	22	17	8	2.33	1.87	1.68	2.28
Mid	44	37	23	11	8	5	4	0.62	3.71	4.76	3.43
Hind	51	49	34	18	16	9	6	0.69	2.73	3.22	4.14
30. <i>Polypedilum circulum</i> sp.n.											
Fore	65	34	73	46	29	23	11	1.15	1.58	1.57	2.83
Mid	58	53	31	15	11	7	5	0.58	3.74	4.83	3.25
Hind	68	58	45	24	22	12	6	0.77	2.67	3.15	3.87
39. <i>Stictochironomus obscurum</i> (Guha & Chaudhuri)											
Fore	43	39	51	30	24	19	11	1.31	1.58	1.52	3.17
Mid	51	45	26	14	11	8	6	0.58	3.13	3.84	3.86
Hind	49	51	40	21	18	11	8	0.78	2.41	2.70	6.14
48. <i>Clinotanypus fuscosignatus</i> (Kieffer)											
Fore	72	85	69	35	22	7	10	0.81	3.05	4.02	2.54
Mid	75	77	53	22	12	5	8	0.69	4.36	6.08	3.30
Hind	68	87	57	28	20	7	9	0.65	3.31	4.30	2.95
49. <i>Procladius noctivagus</i> (Kieffer)											
Fore	40	53	38	18	13	9	7	0.72	2.79	3.21	2.14
Mid	46	45	29	14	10	7	6	0.64	3.24	3.96	3.14
Hind	42	50	34	17	13	8	6	0.68	2.86	3.71	2.87

like; S III simple; S IV 3 segmented; 4 chaetae; 2 spinulae; 3-4 chaetulae laterales; chaetulae basales absent. Pecten epipharyngis comprised of 3 minute toothed plates. Premandible (fig. 15) 0.054 long with 4 unequal teeth, premandibular brush dense and short. Mandible (fig. 16) 0.084 long with 1 apical and 2 lateral teeth, seta subdentalis 0.015 long, seta interna with 4 long and 2 short filaments, 3 seta interna; pecten mandibularis absent; ring organ 0.006 in diameter, distance to ring organ from base 0.009; inner margin smooth. Maxilla with poorly developed lamellae of galea; broad anterior chaeta; leaf like lacinial chaetae; antaxial seta and paraxial seta developed, sensilla basicornica 2; maxillary palp 3 segmented, first segment of maxillary palp 0.021 long, 0.027 wide with ring organ 0.003 in diameter and 2-3 sensilla at its apex; a few chaetulae palpiger, 2 setae maxillaris, SM₁ and SM₂

close to the palpiger, SM₃ and SM₄ close together on the clerie of carido. Prementohypopharyngeal complex (fig. 17) with prementum 0.018 wide, median lamella distinct, 2 well developed paramedian lamellae, 3 of sensilla and 5 of chaetulae. Mentum (fig. 18) 0.033 long and 0.072 wide with broad, pale untoothed central region, flanked by oblique lateral combs of 7 dark pointed teeth. Ventromental plate (fig. 19) fan-shaped 0.03 wide, outer margin smooth, with faint rays ending before the margin.

Abdomen: Brown. Procercus 0.028 long and 0.014 wide, each with 8 anal setae, 0.055 long and 2 short lateral setae. 2 supraanal setae, 0.18 long; Sa/An 0.33. Anterior parapods with numerous weakly sclerotised claws, posterior parapods (fig. 20) 0.182 long with 12-13 sclerotised, variable claws (fig. 21). Anal tubules (fig. 20) conical 0.098 long.

9. *Cryptochironomus rostratus* (Kieffer)

Chironomus rostratus Kieffer, 1911: 164.

Chironomus (Cryptochironomus) rostratus; Goetghebuer 1928: 84.

Chironomus (Chironomus) rostratus; Edwards 1929: 390.

Tendipes (Cryptochironomus) rostratus; Kruseman 1933: 187.

Cryptochironomus rostratus; Pinder 1978: 116; Ree & Kim 1981: 143.

Material examined. – 6 ♂, Howrah, 4 September 1987.

Distribution. – Belgium, The Netherlands, England, Germany, India and Korea.

Differential diagnosis. – i) frontal tubercles small, ii) haltere yellowish green and bare, iii) apical hooks of hind femora pale and inconspicuous, iv) gonostylus short, thick and pointed apex, v) superior volsella thumb-like bearing 3 apical setae and vi) inferior volsella small, lobe-like densely setose.

10. *Cryptochironomus subovatus* Freeman

Chironomus (Cryptochironomus) subovatus Freeman, 1954: 20.

Cryptochironomus subovatus; Freeman 1955a: 375; Freeman 1957: 390; Freeman & Cranston 1980: 189.

Material examined. – 5 ♂, Berhampur, 17 August 1986; Holotype ♂ (Chir. 437.B), Cape Province Berg R., 27 March 1953 (BMNH).

Distribution. – Cape Province, India, Niger, Nigeria, South Africa, Sudan, Upper Volta, and Zaire.

Differential diagnosis. – i) frontal tubercles small, rounded, ii) supraalar 1, iii) spurs of mid and hind tibia unequal, iv) gonocoxite and gonostylus short and broad and v) superior volsella digitiform with 2 long setae at apex and a few small setae over it.

Remarks. – The specimens collected from the rice fields conform fully with those of Freeman (1954), except minor morphometrics.

11. *Dicrotendipes pelochloris* (Kieffer)

Tendipes pelochloris Kieffer, 1912: 39; 1916: 113; Sublette & Sublette 1973: 413 (listed in an unplaced series of Chironomini).

Dicrotendipes pelochloris; Epler 1988: 134.

Limnochironomus niveicauda Kieffer, 1921a: 585.

Chironomus (Limnochironomus) niveicauda; Johannsen 1932: 528.

Dicrotendipes niveicauda; Sublette & Sublette 1973: 404; Hashimoto et al. 1981: 13.

Dicrotendipes niveicaudus; Sasa & Hasegawa 1983: 321; Sasa & Kikuchi 1986: 19.

Chironomus inferior Johannsen, 1932: 534.

Chironomus (Dicrotendipes) wirthi Freeman, 1961a: 692.

Kimius honsooi Ree, 1981: 218.

Xenochironomus loripes Guha & Chaudhuri, 1981: 163.

Einfeldia loripes; Chaudhuri & Guha 1987: 27.

Material examined. – 9 larvae, Burdwan, 7 September 1987; 6 larvae, 7 exuviae, 12 ♂ and 10 ♀ pupae, 8 ♂ and 7 ♀ exuviae, 8 ♂ and 8 ♀, all reared; 2 ♂, Naihati, 16 September 1987.

Distribution. – India, Indonesia, Japan, Korea, Pakistan, Philipines, Taiwan and Thailand.

Differential diagnosis. – Larva: i) plumose SI, ii) pecten epipharyngis a single plate with 5 teeth, iii) premandible with 2 unequal apical teeth, premandibular brush with spines, iv) mandible without pecten mandibularis, inner and outer margin with indentations, v) mentum with dome-shaped median tooth, 5th and 6th lateral teeth appear to be fused and vi) abdominal segment XI with 1 pair short ventral tubules.

Pupa: i) frontal apotome with conical cephalic tubercles, ii) thoracic horn with a bunch of finely branched filaments, iii) tergites V-VIII with median shagreen interrupted in the middle, iv) segment VIII with simple caudolateral spurs ending in a point and v) G/F 0.70 in male and 0.67 in female.

Adult: i) frontal tubercles small, ii) scutellum with 6-8 setae, iii) wing smoky, R₄₊₅ bare, haltere yellow and bare, iv) fore tibial scale blunt bearing 2 long setae, v) tarsomeres II-V dark brown, vi) hypopygium with gonostylus slightly attenuated at apex; superior volsella well developed with setae arranged throughout the body, inferior volsella gently bowed ventrally and vii) genitalia with broad postgenital plate, seminal capsules approximately equal.

12. *Dicrotendipes septemmaculatus* (Becker)

Chironomus septemmaculatus Becker, 1908: 77.

Dicrotendipes septemmaculatus; Cranston & Armitage 1988; Epler 1988: 42.

Dicrotendipes pictipennis Kieffer, 1913a: 23; Freeman 1955b: 22.

Dicrotendipes pilosimanus Kieffer, 1914: 262; Freeman 1955a: 372; Sublette & Sublette 1973: 404; Reiss 1977: 93, 1978: 75, 1986: 159; Freeman & Cranston 1980: 190; Contreras-Lichtenberg 1986: 716; Chaudhuri & Guha 1987: 27.

Chironomus (Dicrotendipes) pilosimanus; Freeman 1954: 19, 1957: 360, 1961b: 247, 1961a: 694.

Dicrotendipes formosanus Kieffer, 1916: 115; Sublette & Sublette 1973: 403; Hashimoto et al. 1981: 12; Sasa & Hasegawa 1983: 320.

Dicrotendipes formosanus var. *frontalis* Kieffer, 1916: 116.

Dicrotendipes speciosus Kieffer, 1924a: 256; Kieffer 1925: 299.

Dicranotendipes speciosus; Kruseman 1949: 254 (mis-spelling).

Stictochironomus sexnotatus Goetghebuer, 1930: 95.

Chironomus hirtitarsis Johannsen, 1932: 534; Sublette & Sublette 1973: 402.

Dicrotendipes hirtitarsis; Guha et al. 1982: 30; Chaudhuri & Guha 1987: 27 (Misspelling).

Polypedilum quatuordecimpunctatum Goetghebuer, 1936a: 488.

Dicrotendipes quatuordecimpunctatus; Contreras-Lichtenberg 1986: 710.

Chironomus (Dicrotendipes) pilosimanus subsp. *guatuordecimpunctatus*; Freeman 1957: 361.

Dicrotendipes rajasthani Singh & Kulshrestha, 1977: 233.

Material examined. – 4 ♂, Burdwan, 6 September 1987; 5 ♂, 9 ♀ Farakka, 29 September 1986.

Distribution. – Algeria, Australia, Bangladesh, Burma, Canary Islands, Egypt, Ethiopia, India, Israel, Japan, Kenya, Lebanon, Malagasy, Malaysia, N. Rhodesia, S. Rhodesia, Spain, Sri Lanka, Sudan, Sumatra, Taiwan, Thailand, Transvaal, Uganda, Yemen and Zaire.

Differential diagnosis. – i) frontal tubercles well developed, ii) scutellum with 12 setae in two rows, iii) wing with 6 grey spots, iv) anal point with broader apex, v) shape of gonostylus, vi) superior volsella bent inward near apex bearing 3-4 apical setae and vii) inferior volsella bifurcated into 2 blunt lobes, larger one with 6-8 and smaller one with 5-6 setae.

13. *Endochironomus pekanus* (Kieffer)

Tendipes pekanus Kieffer, 1916: 105.

Endochironomus pekanus; Ree & Kim 1981: 146.

Material examined. – 2 ♂, Farakka, 29 September 1986; 5 ♂, Naihati, 16 September 1987.

Distribution. – Korea, Taiwan and India (present record).

Differential diagnosis. – i) frontal tubercles absent, ii) fore tibial scale with a sharp pointed spur and 3 long setae, iii) pulvilli moderately developed, iv) characteristic dark stripes on abdominal tergites, v) superior volsella dark with pallor apex and vi) inferior volsella dark brown with 15-17 branched incurved setae.

Remarks. – The curved setae on the inferior volsella, as reported by Ree & Kim (1981) appear to be branched in the specimens recorded here. Otherwise the specific characters conform with the Korean specimens.

14. *Harnischia acuta* (Goetghebuer)

Chironomus (Harnischia) acutus Goetghebuer, 1936a: 470.

Cryptochironomus acutus; Freeman 1955b: 17.

Chironomus (Cryptochironomus) acutus; Freeman 1957: 397.

Harnischia acuta; Sasa & Hasegawa 1983: 323.

Material examined. – 1 ♂, Kalyani, 21 August 1986; 4 ♂, Howrah, 4 September 1987; 2 ♂, Burdwan, 6 September 1987; 1 ♂ paratype (B.M. 1957-264). Transvaal, Neispruit, G. H. Frank (BMNH).

Distribution. – Belgian Congo, Cape Province, Japan, New Zealand, Nigeria and India (present record).

Differential diagnosis. – i) eye gothic shaped

without a dorsal extension, ii) fore tibia with a blunt scale bearing 3 long setae, iii) colour pattern of tarsometers of fore, mid and hind legs, iv) anal point slender with rounded apex, v) gonocoxite with a setose lobe and gonostylus with swollen base and vi) superior volsella reduced and inferior volsella rudimentary.

Remarks. – A study of a paratype specimen from BMNH, London, and comparison with collected specimens reveal that the species should be considered as *Harnischia acuta* (Goetghebuer).

15. *Harnischia incidata* Townes

Harnischia incidata Townes, 1945: 166; Hashimoto et al. 1981: 22.

Material examined. – 5 ♂, Berhampur, 17 August, 1986; 3 ♂, Palasi, 18 August, 1986.

Distribution. – North America, Thailand and India (present record).

Differential diagnosis. – i) frontal tubercles well marked, ii) antepronotum reduced, iii) R_{4+5} with 1 apical seta, iv) haltere light yellow with 6-8 setae, v) spurs of mid tibia unequal and spurs of hind tibia equal, vi) pulvilli small, vii) well marked gonocoxite and gonostylus and viii) superior volsella reduced and inferior volsella absent.

Remarks. – The frontal tubercles recorded in Indian specimens were probably overlooked in the specimens from Thailand (Hashimoto et al. 1981).

16. *Harnischia tenuituberculata* sp. n.

Type material: Holotype ♂, India, West Bengal, Farakka, 29 September 1986, leg. S. Chattopadhyay (Type no. 183, B.U. Ent.). Paratypes: 3 ♂, data as holotype.

Differential diagnosis. – i) antepronotum well developed with emargination in the middle, ii) prescutellars present, iii) ratio of spurs of mid and hind tibia equal, iv) tongue shaped anal point, v) gonostylus oblong with abruptly pointed apex and vi) superior volsella rudimentary.

Remarks. – The species is named *tenuituberculata* because of its small frontal tubercle. It appears to be close to *H. acuta* (Goetghebuer) in body colouration. In its gonocoxite and gonostylus, this species also resembles *H. argentea* Townes, 1945.

Description

Adult. – Male: Body 2.27 (2.20-2.35, $n = 4$) long, wing 1.14 (1.13-1.14, $n = 6$) long and 0.36 (0.35-0.38, $n = 6$) wide.

Head: Brown. Vertex with 7-8 setae (IV 2-3, OV 2, PO 3). Corona bare. Clypeus with 10-12 setae, clypeal ratio 0.86. Maxillary palp pale brown, ratio of palpomere length I-V: 5 : 6 : 27 : 22: 23, L/W

3.8. Eyes gothic shaped with a dorsal extension of 0.018 long. Frontal tubercles (fig. 22) small. Antenna brown, ratio of flagellomere length I-XI : 12 : 8 : 6 : 6 : 5 : 5 : 5 : 5 : 5 : 5 : 160; AR 2.58; pedicel ratio 1.09. CA 0.52; CP 1.40.

Thorax: Yellow. Antepronotum well developed with emargination in the middle, antepronotals 0. Mesonotum with 3 brown vittae. Acrostichals 10-12 biserial, dorsocentrals 7-8, prealars 3, prescutellars 2. Scutellum with 8 setae in a transverse row, postscutellum dark brown and bare.

Wing (fig. 23): Hyaline. Brachiolum with 2 setae and 8-9 sensilla campaniformia. R with 19-20, R_1 with 12-13 and R_{4+5} with 17-18 setae. R_{2+3} meets C at a distance of 0.028 from R_1 ; RM faint and proximal to FCu. An ends proximal to FCu. Squama with 4 setae. Haltere light yellow and bare. CR 0.99; VR 1.12.

Legs: Yellow. Fore tibia with a blunt scale (fig. 24) bearing 2 long setae. Spurs of mid tibia unequal, 0.027 and 0.018 long, ratio of length of spurs to the apical diameter of mid tibia 9 : 11 and 6 : 11; spurs of hind tibia unequal, 0.027 and 0.018 long, ratio of length of spurs to the apical diameter of hind tibia 9 : 13 and 6 : 13. Sensilla chaetica indistinguishable. Pulvilli moderately developed. Proportions and ratios of leg-segments in table 1.

Abdomen: Light yellow. Hypopygium (fig. 25) with tongue-shaped setose anal point 0.042 long and distinctly marked gonocoxite and gonostylus. Gonocoxite with 11 setae; gonostylus oblong with abruptly pointed apex bearing 9 setae at its inner margin and 13-14 setae over it. Superior volsella rudimentary bearing 2 small setae, inferior volsella absent. Transverse sternapodeme 0.06, lateral sternapodeme 0.09, coxapodeme 0.039 and phallapodeme 0.06 long. HR 0.69; HV 1.6.

Female. – Unknown.

Distribution. – India.

17. *Harnischia viridula* (Linnaeus)

Tipula viridula Linnaeus, 1767: 975.

Chironomus (Harnischia) viridulus; Goetghebuer 1928: 86.

Chironomus (Chironomus) viridulus; Edwards 1929: 390. *Cryptocladopelma viridula*; Pinder 1978: 18.

Harnischia viridula; Hashimoto et al. 1981: 21; Sasa & Hasegawa 1983: 324; Sasa 1985: 35; Sasa & Kikuchi 1986: 20.

Material examined. – 5 ♂, Burdwan 30 May 1986; 3 ♂, Chinsura, 5 February 1987.

Distribution. – England, Japan, North America, Sweden, Thailand and India (present record).

Differential diagnosis. – i) frontal tubercles well developed, ii) postscutellum bearing 2 setae, iii) R_{4+5} with 1-2 apical setae, iv) pulvilli well deve-

loped, v) unmarked gonocoxite and gonostylus and vi) superior volsella rudimentary bearing 2 setae.

18. *Kiefferulus barbatitarsis* (Kieffer)

Chironomus barbatitarsis Kieffer, 1911: 154.

Kiefferulus barbatitarsis; Chaudhuri & Ghosh 1986: 277; Chaudhuri & Guha 1987: 28.

Material examined. – 6 larvae, Uttrpara, 9 September 1987; 7 larvae, 8 ♂ and 6 ♀ pupae, 4 ♂ and 5 ♀ exuviae, 6 ♂ and 5 ♀ all reared; 5 ♂, Howrah, 4 September 1987; 4 ♂, Kalyani, 10 February 1986; 9 ♂, Hooghly, 4 September 1987.

Distribution. – India.

Differential diagnosis. – Larva: i) S I of labrum densely pectinate, ii) pecten epipharyngis with 18 unequal teeth, iii) ventromental plate with wrinkled outer surface and iv) posterior parapods with 15-16 well-sclerotized claws.

Pupa: i) thoracic horn with a bunch of fine filaments, and ii) segment VIII with 1 pair of caudo-lateral spurs, each with 4-5 teeth in male and 8-10 in female.

Adult: i) scutellum with 20 setae in two transverse rows, ii) brachiolum with 4 setae and iii) hypopygium with tongue-like anal point, superior volsella bent with subacute apex and bare and inferior volsella curved with blunt apex bearing numerous curved setae.

19. *Kiefferulus calligaster* (Kieffer)

Chironomus calligaster Kieffer, 1911: 160.

Kiefferulus calligaster; Chaudhuri & Ghosh 1986: 285; Chaudhuri & Guha 1987: 28.

Material examined. – 5 larvae, Burdwan, 14 September 1986; 6 larvae, 6 ♂ and 7 ♀ pupae, 5 ♂ and 6 ♀ exuviae, 9 ♂ and 6 ♀ all reared; 2 ♂, Kalyani, 26 October 1986; 5 ♂, Kalna, 4 February 1988.

Distribution. – India.

Differential diagnosis. – Larva: i) S I of labrum plumose, ii) premandible with 5 curved apical teeth and well developed premandibular brush, iii) ventromental plate with smooth outer surface, and iv) posterior parapods long, each with 13-14 claws.

Pupa: i) frontal apotome with 1 pair of funnel-shaped cephalic tubercles, ii) thoracic horn with 2 plumose branches, iii) tergite VII without shagreen and iv) segment VIII with 1 pair blunt, weak caudo-lateral spurs.

Adult: i) scutellum with 6 setae in a single transverse row, ii) brachiolum with 2 setae, iii) fore femur with apical band, iv) pulvilli large and broad and v) hypopygium with dark peglike anal point, and superior volsella with swollen base bearing 5 setae.

20. *Microchironomus fuscitarsus* (Guha & Chaudhuri)

Cryptochironomus fuscitarsus Guha & Chaudhuri, 1979: 95.

Microchironomus fuscitarsus; Chaudhuri & Chattopadhyay 1988: 175.

Material examined. – 7 larvae, Howrah, 8 March 1987; 3 larvae, 8 ♂ and 8 ♀ pupae, 5 ♂ and 7 ♀, exuviae, 8 ♂ and 8 ♀, all reared; 3 ♂, Burdwan, 6 September 1987.

Distribution. – India.

Differential diagnosis. – Larva: i) blade-like S I and S II, ii) premandible with 2 unequal apical teeth, iii) mandible with well developed pecten mandibularis and iv) fan-shaped ventromental plate with wrinkled outer margin.

Pupa: i) conical cephalic tubercles without frontal seta, ii) thoracic horn with 4 main bunch of finely branched filaments, iii) tergites I, II and VII bare and iv) caudolateral spur on segment VIII simple with sharp point.

Adult: i) antepronotum with 5 antepronotals, ii) scutellum with 10 setae, iii) fore tibial scale with 2 long setae and iv) hypopygium with small setaceous lobe basolateral to anal point; superior volsella with 1 apical seta.

21. *Microchironomus tener* (Kieffer)

Chironomus tener Kieffer, 1918: 48.

Tendipes (Parachironomus) tener; Kruseman 1933: 125, 190-191.

Leptochironomus tener; Kugler 1971: 341; Shilova 1976: 118-119; Pinder 1978: 126.

Microchironomus tener; Saether 1977: 101; Freeman & Cranston 1980: 193; Moller-Pillot 1984: 244; Chaudhuri & Chattopadhyay 1988: 177.

Parachironomus tener; Hashimoto et al. 1981: 19.

Cryptochironomus aegyptius Kieffer, 1925: 288.

Chironomus (Cryptochironomus) balticus Pagast, 1931: 218.

Chironomus forcipatus Freeman, 1954: 20; 1957: 394; 1961a: 699.

Material examined. – 9 larvae, Kalyani, 17 February 1987; 5 larvae, 6 ♂ and 5 ♀ pupae, 4 ♂ and 5 ♀ exuviae, 6 ♂ and 3 ♀, all reared.

Distribution. – Australia, Chad, Ghana, India, Madagascar, Poland, Rhodesia, South Africa and Zaire.

Differential diagnosis. – Larva: i) pecten epipharyngis indistinct, ii) mandible with 3 flat lateral teeth; seta interna with 3-4 filaments; pecten mandibularis absent, iii) mentum with minute 4th lateral tooth and iv) ventromental plate fan-shaped with faint rays ending before the margin.

Pupa: i) elevated cephalic tubercle with an apical seta, ii) tergites I and II bare, and iii) pattern of shagreen on tergites and lateral setae on segments.

Adult: i) frontal tubercles absent, ii) haltere with

7-10 setae and iii) hypopygium with stout anal point and large setaceous lobe basolaterally; superior volsella long and slender with 2-3 setae at apex.

22. *Paracladopelma aratra* sp. n.

Type material. – Holotype ♂, India, West Bengal, Bally, 9 March 1987, leg. S. Chattopadhyay (Type no. 184, B.U. Ent.). Paratypes: 4 ♂, data as holotype.

Differential diagnosis. – i) frontal tubercles absent; ii) prescutellar 1, iii) R_{4+5} with 2 setae at the apex, iv) spurs of hind tibia equal, v) superior volsella strongly sclerotised appearing as an outgrowth of the gonostylus, inferior volsella plough-like and vi) anal point tubular.

Remarks. – *Paracladopelma aratra* is named *aratra* because of its plough-shaped inferior volsella of the male hypopygium. In the structure of the gono-coxite and gonostylus of the male hypopygium, the present species resembles *P. graminicolor* (Kieffer). The anal point of the male hypopygium shows similarity to that of *P. brincki* (Freeman).

Description

Adult. – Male: Body 2.09 (2.06-2.11, n = 5) long, wing 0.91 (0.91-0.92, n = 6) long and 0.31 (0.29-0.31, n = 6) wide.

Head: Brown. Vertex with 7-9 setae (IV 2-3, OV 3-4, PO 2). Corona bare. Clypeus with 10-12 setae, clypeal ratio 0.94. Maxillary palp pale brown, ratio of palpomere length I-V: 9 : 6 : 19 : 24 : 33; L/W 3.8. Eyes reniform without a dorsal extension. Frontal tubercles absent. Antenna brown, ratio of flagellomere length I-XI: 12 : 6 : 5 : 5 : 6 : 6 : 7 : 7 : 7 : 7 : 102; AR 1.5; pedicel ratio 1.2 CA 0.66; CP 1.23

Thorax: Yellow. Antepronotum well developed without emargination, antepronotals O. Mesonotum with 3 brown vittae. Acrostichals 4-6 irregularly biserial, dorsocentrals 5-6 uniserial, prescutellar 1, prealars 3. Scutellum with 4-6 setae, postscutellum dark brown and bare.

Wing (fig. 26): Opaque, veins light brown. Brachiolum with 1 seta and 16-18 sensilla campaniformia. R and R_1 without seta; R_{4+5} with 2 setae at the apex; R_{2+3} meets C at distance of 0.981 from R_1 ; RM faint and proximal to FCu. Squama with 5-6 setae. Haltere light yellow with 9-11 setae. CR 0.95; VR 1.23.

Legs: Yellow. Fore tibia with a blunt scale (fig. 27) bearing 2 long setae. Spurs of mid tibia equal 0.018 long, ratio of length of spurs to the apical diameter of mid tibia 6 : 9; spurs of hind tibia equal 0.021 long, ratio of length of spurs to the apical diameter of hind tibia 7 : 11. Femur, tarsomere 1 of fore leg and tarsomere V of mid and hind leg brown. Sensilla chaetica indistinguishable. Pulvilli well developed. Proportions and ratios of leg-segments in table 1.

Abdomen: Yellow. Hypopygium (fig. 28) with tubular anal point 0.036 long and with 3-5 basolateral setae. Gonocoxite with 6-7 gonostylus short and stout bearing 8 setae at its inner margin and 11-12 setae over it. Superior volsella strongly sclerotised appearing as an outgrowth of the gonostylus; inferior volsella more or less plough like having 2 long setae. Transverse sternapodeme 0.033, lateral sternapodeme 0.069, coxapodeme 0.033 and phallapodeme 0.036 long. HR 0.79; HV 2.71.

Female. – Unknown.

Distribution. – India.

23. *Paracladopelma sacculifera* sp. n.

Type material. – Holotype ♂, India, West Bengal, Kalyani, 17 February, leg. S. Chattopadhyay (Type no. 185, B.U. Ent.). Paratypes: 5 ♂, data as holotype.

Differential diagnosis. – i) frontal tubercles very small, ii) antepronotum very thin without dorsal emargination, iii) spur of hind tibia unequal, iv) superior volsella short and broad, inferior volsella finger like and each with 1 long seta and v) anal point with saccular tip.

Remarks. – The name of the species is derived from the saccular tip of the anal point of the male hypopygium. The species seems to be nearer to *P. campylobolis* (Kieffer), *P. naïs* (Townes) and *P. doris* (Townes) in respect of the anal point, but to *P. undine* (Townes) in view of the gonostylus of the male hypopygium.

Description

Adult. – Male: Body 2.77 (2.79-2.88, n = 6) long, wing 1.58 (1.58-1.60, n = 6) long and 0.49 (0.48-0.49, n = 6) wide.

Head: Brown. Vertex with 12-13 setae (IV 3-4, OV 5-6, PO 4). Clypeus with 18-19 setae, clypeal ratio 0.92. Maxillary palp pale brown, ratio of palpomere length I-V : 10 : 11 : 34 : 32 : 35; L/W 4.86. Eyes reniform without a dorsal extension. Frontal tubercles (fig. 29) very small. Antenna brown, ratio of flagellomere length I-XI : 12 : 7 : 6 : 6 : 7 : 7 : 7 : 7 : 137; AR 1.90; pedicel ratio 1.09. CA 0.53; CP 0.92.

Thorax: Yellow. Antepronotum very thin without dorsal emargination, antepronotals O. Mesonotum with 3 brown vittae. Acrostichals 10-11 irregularly biserial, dorsocentrals 7-8 uniserial, prealars 4. Scutellum with 10 setae, postscutellum dark brown and bare.

Wing (fig. 30): Opaque, veins light brown. Brachiolum with 1 seta 10-12 sensilla campaniformia. R with 7-9 setae, R_1 and R_{4+5} without seta. R_{2+3} meets C at a distance of 0.05 from R_1 ; RM faint and proximal to FCu; An ends below FCu. Squama with

5-6 setae. Haltere yellowish green with 6-7 setae. CR 0.92; VR 1.19.

Legs: Yellow. Fore tibia with a blunt scale (fig. 31) bearing 2 long setae. Spurs of mid tibia subequal 0.018 and 0.015 long, ratio of length of spurs to the apical diameter of mid tibia 6 : 13 and 5 : 13; spurs of hind tibia unequal 0.021 and 0.012 long, ratio of length of spurs to the apical diameter of hind tibia 7 : 15 and 4 : 15. Apex of fore tibia and tarsomeres of fore, mid and hind legs brown. Sensilla chaetica indistinguishable. Pulvilli well developed. Proportions and ratios of leg-segments in table 1.

Abdomen: Yellow. Hypopygium (fig. 32) with anal point with saccular apex bearing 8-9 setae at its base. Gonocoxite short with 8-10 setae; gonostylus long and little incurved with 11-13 small setae in its inner margin and 15-17 setae over it. Superior volsella short, broad and pubescent bearing 1 long seta; inferior volsella finger like bearing 1 long and numerous minute setae. Transverse sternapodeme 0.042, lateral sternapodeme 0.087, coxapodeme 0.054 and phallapodeme 0.042 long. HR 0.65; HV 1.98.

Female. – Unknown.

Distribution. – India.

24. *Pentapedilum robusticeps* Guha & Chaudhuri

Pentapedilum robusticeps Guha & Chaudhuri, 1985: 195.

Material examined. – 4 ♂, Palasi, 18 August 1986; 5 ♂, Utarpura, 24 February 1987.

Distribution. – India.

Differential diagnosis. – i) scutellum with 26 setae in two transverse rows, ii) brachiolum with 7 setae and iii) hypopygium with robust anal point, stout gonostylus, narrow superior volsella and finger like inferior volsella.

25. *Pentapedilum uncinatum* (Goetghebuer)

Tanytarsus uncinatus Goetghebuer, 1921: 110.

Pentapedilum uncinatum; Edwards 1929: 376; Pinder 1978: 134; Sasa & Kikuchi 1986: 21.

Material examined: 7 ♂, Kalyani, 17 February 1987; 1 ♂, Spain, Levida, 6 July 1973, Coll. P. S. Cranston (BMNH).

Distribution. – Belgium, England, Germany, Japan, Spain and India (present record).

Differential diagnosis. – i) frontal tubercles absent, ii) fore tibia with a blunt scale bearing 3 setae, iii) length of mid and hind tibia equal, iv) pulvilli moderately developed, v) superior volsella with 1 long lateral seta arising at about the distal 2/3 from the base.

26. *Polypedilum aegyptium* Kieffer

Polypedilum aegyptium Kieffer, 1925: 270; Freeman 1958: 281; Guha & Chaudhuri 1983: 635; Chaudhuri & Guha 1987: 28.

Polypedilum iris Goetghebuer, 1937: 61.

Polypedilum airense Freeman, 1956: 96.

Material examined. – 5 ♂, Chinsura, 6 February 1987.

Distribution. – Africa, Egypt and India.

Differential diagnosis. – i) frontal tubercles absent, ii) thorax dark brown, iii) triangular fore tibial scale having a sharp spine, iv) wing with brown markings and clouds and v) superior volsella more angular.

27. *Polypedilum annulatipes* (Kieffer)

Chironomus annulatipes Kieffer, 1910: 234.

Polypedilum annulatipes; Kieffer 1921b: 100, 1922: 30; Freeman 1958: 277-278; Sublette & Sublette 1973: 407; Chaudhuri et al. 1981: 115-117; Chaudhuri & Guha 1987: 28.

Polypedilum octostictum Kieffer, 1921b: 101, 1922: 39.

Polypedilum octomaculatum Goetghebuer, 1934: 195, 1936a: 488.

Material examined. – 6 ♂, Bally, 13 February 1986; 1 ♂, India, Orissa, Barkuda Lake, 1 October 1922, leg. N. Annadale (NZC, Calcutta).

Distribution. – Africa, Egypt, India, Pakistan and Zaire.

Differential diagnosis. – i) presence of single spur in mid and hind tibia, ii) absence of frontal tubercles, iii) antepronotum not collar-like and iv) abdominal segment VIII constricted at the base.

Remarks. – From the present study it may be inferred that *P. annulatipes* is a distinct species in the genus *Polypedilum* Kieffer.

28. *Polypedilum ascium* Chaudhuri, Guha & Das Gupta

Polypedilum ascium Chaudhuri, Guha & Das Gupta, 1981: 117-119; Chaudhuri & Guha 1987: 28.

Material examined. – 4 ♂, Palasi, 18 August 1986; 1 ♂, Chinsura, 6 February 1987.

Distribution. – Bhutan and India.

Differential diagnosis. – i) mesonotum brown with dark brown patches, ii) antepronotum very thin, iii) scutellum with 6 setae, iv) fore tibial scale elongated and blunt and v) inferior volsella axe-shaped.

29. *Polypedilum chaudhuri* Chaudhuri, Guha & Das Gupta

Polypedilum chaudhuri Chaudhuri, Guha & Das Gupta, 1981: 119-122; Chaudhuri & Guha 1987: 28.

Material examined. – 16 ♂, Naihati, 16 September 1987.

Distribution. – India.

Differential diagnosis. – i) colour pattern of wing, ii) colour bands of the legs, iii) two rows of scutellar setae, iv) spur of mid tibia bent and v) hypopygium with anal point bearing two projections, superior volsella with uniform width, gently bent at the middle bearing 4 setae and numerous weak setae and elongated, little bowed inferior volsella.

30. *Polypedilum circulum* sp. n.

Type material. – Holotype ♂, India, West Bengal, Kalyani, 25 October 1986, leg. S. Chattopadhyay (Type no. 186, B.U. Ent.). Paratypes: 8 ♂, data as holotype.

Differential diagnosis. – i) frontal tubercles absent, ii) antepronotum transparent with some cone shaped apex and emargination in the middle, iii) haltere dark brown with 6-8 setae, iv) spurs of mid and hind tibia equal, v) colour pattern of the abdomen, vi) anal point slender, ending just before tip of appendage 2, vii) gonocoxite short, gonostylus clavate with 6 long setae on its inner margin, viii) superior volsella curved with blunt tip and 1 long lateral seta near the base.

Remarks. – *Polypedilum circulum* is named after the slender appendage 1 of the male hypopygium. The present species resembles *P. nubeculosum* (Meigen) and *P. youngosanensis* Ree & Kim in the gonostylus and *P. angustum* Townes in appendage 1. The anal point of the male hypopygium also shows similarities with that of *P. acutum* Kieffer and *P. angustum* Townes.

Description

Adult. – Male: Body 3.37 (2.29-3.58, n = 9) long, wing 1.76 (1.75-1.79, n = 10) long and 0.53 (0.52-0.55, n = 10) wide.

Head: Brown. Vertex with 15-17 setae (IV 4-5, OV 7-8, PO 4). Corona bare. Clypeus with 17-19 setae, clypeal ratio 0.85. Maxillary palp pale brown, ratio of palpolmere length I-V: 10 : 8 : 19 : 24 : 35; L/W 3.80. Eyes reniform with a dorsal extension of 0.01 long. Frontal tubercles absent. Antenna brown, ratio of flagellomere length I-XIII: 19 : 7 : 8 : 7 : 7 : 7 : 6 : 7 : 7 : 7 : 7 : 194; AR 2.02; pedicel ratio 0.85. CA 0.50; CP 1.55.

Thorax: Brown. Antepronotum transparent with cone shaped apex and slight emargination in the middle, antepronotals O. Mesonotum brown. Acrostichals 10-11 irregularly biserial, dorsocentrals 8-9 uniserial, prealars 2-3. Scutellum with 6 setae in a transverse row, postscutellum dark brown and bare.

Wing (fig. 33): Hyaline. Brachiolum with 1 seta and 21-23 sensilla campaniformia. R with 17-18, R_1 with 11-12 and R_{4+5} with 19 setae; R_{2+3} meets C at a distance of 0.04 from R_1 ; RM pale and proximal to FCu. An ends proximal to FCu. Squama with 8 setae. Haltere dark brown with 6-8 setae. CR 0.98; VR 1.16.

Legs: Yellow. Fore tibia with a triangular scale (fig. 34) bearing a very short apical spine and 2 long setae. Mid tibia with single spur 0.027 long, ratio of length of spur to the apical diameter of mid tibia 9 : 13, hind tibia with single spur 0.027 long, ratio of length of spur to the apical diameter of hind tibia 9 : 15. Basal and apical portion of fore tibia dark brown, tarsomeres uniform in colour; tarsomere V of mid and hind leg yellow to pale brown. Sensilla chaetica indistinguishable. Pulvilli moderately developed. Proportions and ratios of leg-segments in table 1.

Abdomen (fig. 35): Tergites yellowish brown with dark brown band along lateral margin, tergites III and VI with dark brown median patches in addition to the above. Hypopygium (fig. 36) with tubular anal point 0.042 long, subequal to appendage 2 and with 4-5 basolateral setae. Gonocoxite short, stout with 7-9 setae; gonostylus clavate with 1 apical seta, 6 long setae on its inner margin and 12-14 setae over it. Superior volsella slender, bent inward with 3 basal setae and 1 long lateral seta near the base; inferior volsella stout, linear with 11-12 incurved setae besides single long apical seta. Transverse sternapodeme 0.036, lateral sternapodeme 0.066, coxapodeme 0.048 and phallapodeme 0.075 long. HR 0.44; HV 1.27.

31. *Polypedilum lineatum* Chaudhuri, Guha & Das Gupta

Polypedilum lineatum Chaudhuri, Guha & Das Gupta, 1981: 129-131; Chaudhuri & Guha 1987: 28.

Material examined. - 9 ♂, Haldia, 16 October 1987.

Distribution. - India.

Differential diagnosis. i) corona with setae, ii) frontal tubercles absent, iii) antepronotum dark, very thin without dorsal emargination, and superior volsella well developed, wider at the apex, with numerous small setae.

32. *Polypedilum nubifer* (Skuse)

Chironomus nubifer Skuse, 1889: 249; Kieffer 1906: 20; 1917: 205.

Polypedilum (Polypedilum) nubifer; Freeman 1961a: 707. *Polypedilum nubifer*; Martin 1966: 157; Sublette & Sublette 1973: 408; Porter & Martin 1977: 41; Sasa & Sublette 1980: 33; Hashimoto et al. 1981: 23; Ree & Kim 1981: 158; Sasa & Hasegawa 1983: 327; Sasa & Kikuchi 1986: 26; Chaudhuri & Guha 1987: 28; Chattopadhyay et al. 1988: 29.

Chironomus tripartitus Kieffer, 1910: 231 (see Freeman 1961).

Chironomus ceylonicus Kieffer, 1911: 136 (see Freeman 1961).

Polypedilum pelostolum Kieffer, 1912: 41 (see Freeman 1961).

Polypedilum pharao Kieffer, 1925: 274 (see Freeman 1961).

Chironomus (Polypedilum) albiceps Johannsen, 1932: 515.

Polypedilum (Polypedilum) albiceps; Tokunaga 1964: 583.

Chironomus (Polypedilum) octoguttatus Tokunaga, 1936: 83.

Polypedilum octoguttatum; Sasa 1979: 15.

Material examined. - 5 larvae, Burdwan, 14 September 1986; 8 larvae, 4 ♂ and 5 ♀ pupae, 6 ♂ and 5 ♀ exuviae, 7 ♂ and 7 ♀, all reared; 2 ♂, Kalyani, 10 February 1986; 3 ♂, Chinsura, 6 February 1987; 5 ♂, Hooghly, 4 September 1987; 2 ♂, Uttarpara, 9 September 1987.

Distribution. - Africa, Australia, Egypt, Indonesia, India, Iraq, Japan, Korea, Micronesia, Morocco, Sri Lanka and Taiwan.

Differential diagnosis. - Larva: S I and S II plumose, ii) pecten epipharyngis comprising 3 toothed plates, iii) premandible with 2 unequal apical teeth, iv) seta interna with 3 main plumose branches and v) mentum with short 1st and 7th lateral teeth.

Pupa: i) frontal apotome with elevated cephalic tubercles, ii) thoracic horn with 4 main bunches of finely branched filaments, iii) tergites I and VIII bare, iv) absence of dorsal seta on segment VIII and v) caudolateral spur of segment VIII with 14-24 variable, stout spines.

Adult: i) frontal tubercles small, ii) wing with 10 spots, iii) squama fringed, and iv) hypopygium with slender anal point, gonostylus attenuated with 1 long seta at apex; inferior volsella with 1 long seta at apex.

33. *Polypedilum medivittatum* Tokunaga

Polypedilum (Polypedilum) medivittatum Tokunaga, 1964: 588; Sasa & Hasegawa 1983: 329.

Chironomus (Polypedilum) sp. no. 17, Johannsen 1932: 524.

Material examined. - 6 ♂, Kalyani, 26 October 1986.

Distribution. - Caroline Islands (Palau, Yap and Panope), Japan, S. Mariana Islands (Gham), South Sumatra and India (present record).

Differential diagnosis. - i) antepronotum narrow without emargination, ii) scutellum with 2-4 setae, iii) haltere yellow with 5 setae, iv) pulvilli well developed, v) tergites I-VI light yellow and tergite VIII brown, vi) superior volsella scimitar like and vii) inferior volsella not beyond tip of anal point.

34. *Polypedilum suturalis* (Johannsen)

Chironomus (Polypedilum) suturalis Johannsen, 1932: 522.
Polypedilum suturalis; Sublette & Sublette 1973: 408; Hashimoto et al. 1981: 25.

Material examined. - 6 ♂, Haldia, 16 October 1987.

Distribution. - South Sumatra, Thailand and India (present record).

Differential diagnosis. - i) prescutellar 1, ii) fore tibial scale triangular bearing a short subapical spine and 2 long setae, iii) apical diameter of mid and hind tibiae is lesser than the length of spurs, iv) colour pattern of abdomen, v) anal point long with pointed inwardly bent apex, vi) superior volsella very slender, arcuate with 1 seta on subbasal part and 11-12 minute setae and vii) inferior volsella not reaching tip of the anal point.

35. *Polypedilum yapensis* Tokunaga

Polypedilum (Polypedilum) yapensis Tokunaga, 1964: 595; Hashimoto et al. 1981: 25.

Material examined. - 9 ♂, Howrah, 8 March 1987; 3 ♂, Bally, 8 March 1987.

Distribution. - Caroline Islands (Palau, Yap), Thailand and India (present record).

Differential diagnosis. - i) frontal tubercles well developed, setose, ii) scutellum with 4 setae, iii) fore tibia with a blunt scale bearing 2 setae, iv) length of spur of mid and hind tibia equal, v) superior volsella slender and with 1 long seta behind tip and vi) anal point slender ending before the tip of inferior volsella.

Remarks. - The Indian specimens are slightly different from the Micronesian specimens in body colouration, but the main specific characters seem to be identical. The frontal tubercle, which has been reported to be absent by Hashimoto et al. (1981), has been noted in the present specimens.

36. *Stenochironomus hilaris* (Walker)

Chironomus hilaris Walker, 1848: 17.
Stenochironomus hilaris; Townes 1945: 90; Beck & Beck 1970: 33; Gillespie 1974: 238.
Stenochironomus (Stenochironomus) hilaris; Borkent 1984: 69.
Chironomus taeniapennis Coquillett, 1901: 607; Johannsen 1905: 203; Malloch 1915: 430.
Chironomus (Stenochironomus) taeniapennis; Johannsen 1937: 28.
Stenochironomus taeniapennis; Townes 1945: 90 (in part).
Chironomus nephopterus Mitchell, 1908: 7; Johannsen 1908: 280; Malloch 1915: 429.
Chironomus nephopterus [Sic]; Johannsen 1908: 280.
Stenochironomus nephopterus; Townes 1945: 90.
Chironomus zonopterus Mitchell, 1908: 12.
Stenochironomus zonopterus; Townes 1945: 91.

Chironomus exquisitus Mitchell, 1908: 11.

Chironomus (Stenochironomus) equisitus; Johannsen 1937: 28.
Stenochironomus exquisitus; Townes 1945: 91.

Material examined. - 4 ♂, Farakka, 29 September 1986.

Distribution. - Canada, U.S.A. and India (present record).

Differential diagnosis. - i) high value of L/W (7.14), ii) scutellum with 30 setae in two transverse rows, iii) wing with lightly pigmented medial and apical bands, iv) colour pattern of legs, v) fore tibia with a blunt scale bearing 4 long setae, vi) dark anal point with hyaline expanded tip and vii) superior volsella short with 6 setae.

37. *Stenochironomus longipalpis* (Kieffer)

Tendipes longipalpis Kieffer, 1913b: 132.
Stenochironomus longipalpis; Sublette & Sublette 1973: 409.

Material examined. - 3 ♂, Palasi, 18 August 1986.

Differential diagnosis. - i) scutellum with 14 setae in a transverse row, ii) wing unmarked, iii) fore tibia with an elongated scale bearing a short spur and 4 long setae, iv) superior volsella short and inconspicuous bearing 5-6 setae and v) inferior volsella with 3 long curved setae on inner apical margin.

Remarks. - As the type is reported to be lost from NZC, Calcutta, the species is here redescribed in order to fix its identity.

Redescription

Adult. - Male: Body 3.51 (3.43-3.68, n = 3) long, wing 1.48 (1.45-1.50, n = 6) long and 0.38 (0.37-0.39, n = 6) wide.

Head: Brown. Vertex with 12-17 setae (IV 4-6, OV 8-10, PO 0-1). Corona bare. Clypeus with 18-20 setae, clypeal ratio 1.11. Maxillary palp brown, ratio of palpalomere length I-V: 10 : 8 : 17 : 40 : 41; L/W 2.42. Eyes reniform without a dorsal extension. Frontal tubercles absent. Antenna brown, ratio of palpalomere length I-XIII: 17 : 6 : 7 : 8 : 8.5 : 8.5 : 8.5 : 8.5 : 8.5 : 8.5 : 178; AR 1.68; pedicel ratio 1.18. CA 0.66; CP 2.16.

Thorax: Light brown. Antepronotum reduced, antepronotals O. Mesonotum with 4 dark vittae (1 pair dorsomesad, parallel to each other and one each dorsolaterad). Acrostichals 16 irregularly biseriatal, dorsocentrals 17 uniserial, humeral 0.1, prealars 5-6. Scutellum with 14 setae in a transverse row, postscutellum dark brown and bare.

Wing (fig. 37): Unmarked with pale brown veins. Brachiolum with 2 setae and 14-15 sensilla campaniformia. R with 30-34, R_1 with 31-35 and R_{4+5} with 64-70 setae; R_{2+3} ending close to R_1 ; RM brown, thick and proximal to FCu. An ends below

FCu. Squama with 7-8 setae. Haltere yellow with 6-7 setae. CR 0.97; VR 1.11.

Legs: Yellow. Fore tibia with an elongated scale (fig. 38), armed with a short spur, 0.003 long bearing 4 long setae. Spurs of mid tibia subequal 0.027 and 0.024 long, ratio of length of spurs to the apical diameter of hind tibia 9 : 15 and 8 : 15; spurs of hind tibia also subequal 0.024 and 0.021 long, ratio of length of spurs to the apical diameter and hind tibia 8 : 16 and 7 : 16. Apex of fore femur brown, fore tibia dark at base and apex but mid and hind tibiae brown only at base. Tarsomeres broken in all specimens.

Abdomen (fig. 39): Uniformly setaceous with a large number of long setae at each lateral margin. Tergites yellow with brownish tinge except the base of tergites I-IV with dark brown. Hypopygium (fig. 40) with dark, stout anal point, apex broad, rounded bearing 7-8 basolateral setae. Gonocoxite with 7-9 long setae; gonostylus long, slender, evenly curved bearing 1 long apical seta, 3-4 setae on inner margin and 11-13 setae over it. Superior volsella short and inconspicuous bearing 5-6 setae; inferior volsella long, narrow and curved with an articulated spine of 0.015 long at tip and 3 long setae on inner apical margin. Transverse sternapodeme 0.024, lateral sternapodeme 0.06, coxapodeme 0.03, and phallapodeme 0.063, long. HR 0.70, HV 2.09.

Female. – Unknown.

38. *Stictochironomus affinis* (Johannsen)

Chironomus (Stictochironomus) affinis Johannsen, 1932: 525.

Stictochironomus affinis; Ali et al. 1987; Chaudhuri & Guha 1987: 29.

Material examined. – 8 larvae, Katwa, 8 February 1987; 5 larvae, 9 ♂ and 8 ♀ pupae, 5 ♂ and 6 ♀ exuviae, 8 ♂ and 4 ♀, all reared; 6 ♂, Uttarpara, 24 February 1987; 3 ♂, Berhampur, 2 January 1988.

Distribution. – India and Indonesia.

Differential diagnosis. – Larva: i) SI and S II plumose and ii) pecten epipharyngis comprising 3 toothed plates, median with 3-5 and each lateral with 5 teeth.

Pupa: i) tergite I with uniformly distributed spinules, ii) segments II-VIII with 2, 3, 3, 3, 3, 4, 4 pairs of lateral setae and iii) caudolateral spur on segment VIII with 7-8 spines.

Adult: i) corona bare, ii) frontal tubercles present, iii) scutellum with dark posterior border bearing 24 setae, iv) haltere bare and v) hypopygium with curved, pointed superior volsella and slender anal point with subacute apex.

Remarks. – This species was described by Johannsen (1932) from a female, collected on Bali, Indonesia. Ali et al. (1987) confirmed the identity

of this species by comparing reared specimens with the description by Johannsen and by examining the type, received from BMNH, London. They also made a detailed description of the life stages, with a brief account of the general behaviour of larvae and the ovipository behaviour of the female.

39. *Stictochironomus obscurus* (Guha & Chaudhuri) comb. n.

Polypedilum obscurum Guha & Chaudhuri, 1983: 637.

Material examined. – 6 larvae, Burdwan 30 May 1986; 6 larvae, 8 ♂ and 8 ♀ pupae, 5 ♂ and 5 ♀ exuviae, 10 ♀, all reared; 2 ♂, Bally, 9 March 1987.

Distribution. – India.

Differential diagnosis. – Larva: i) AR 0.74, ii) S I and S II leaf like, iii) pecten epipharyngis comprising 3 toothed plates, median with 3 and each lateral with 8 teeth, iv) premandible with 2 blunt, unequal apical teeth and 1 small inner tooth and v) pecten mandibularis unmarked.

Pupa: i) conical, apically bent cephalic tubercle bearing subapical seta, ii) pedes spurii B caudolateral on segment II and basolateral on segment I, iii) tergite I bare, iv) segments II-VIII with 4, 3, 6, 6, 5, 6, 2 pairs of dorsal setae and 3, 2, 3, 3, 3, 4, 4, pairs of lateral setae, v) caudolateral spur on segment VIII with 9-11 stout spines.

Adult: i) corona with 4 setae, ii) frontal tubercles absent, iii) haltere light brown bearing 4-5 setae, iv) scutellum with 18 irregular setae, v) pattern of wing markings, vi) superior volsella stout, bent bearing 3 basal setae and vii) dark, slender anal point with an apical rounded knob and seminal capsules opening separately into the vagina.

Remarks. – The adult male and female of this species were described from West Bengal and Arunachal Pradesh, India. It requires mentioning here that the structural pattern of the teeth of the larval mentum deviates from that stated by Pinder and Reiss (1983), but other larval and pupal characters clearly support its present recombination with the genus *Stictochironomus* Kieffer.

Redescription

Adult. – Male: Body 3.93 (3.88-4.04, n = 8) long, wing 1.62 (1.61-1.64, n = 10) long and 0.52 (0.50-0.55, n = 10) wide.

Head: Brown. Vertex with 13-15 setae (IV 5-6, OV 6-7, PO 2). Corona with 4 setae. Clypeus with 24-25 setae, clypeal ratio 0.86. Maxillary palp brown, ratio of palpalomere length I-V: 9 : 15 : 36 : 34 : 57; L/W 4.5. Eyes reniform with a dorsal extension of 0.02 long. Frontal tubercles absent. Antenna brown, ratio of flagellomere length I-XI: 15 : 6 : 6 : 6 : 6 : 6 : 6 : 6 : 6 : 165; AR 2.2; pedicel ratio 1.15 . CA 0.62; CP 0.99.

Thorax: Dark brown. Antepronotum collar-like with slight emargination in middle, antepronotals O. Mesonotum brown. Acrostichals 18 irregularly biserial, dorsocentrals 19-21 uniserial, prealars 4-5. Scutellum with 18 irregular setae, postscutellum dark brown and bare.

Wing (fig. 41): Hyaline. Brachiolum with 1 seta and 9-11 sensilla campaniformia. R with 17, R_1 with 8 and R_{4+5} with 15-16 setae; R_{2+3} meets C at a distance of 0.108 from R_1 ; RM proximal to FCu. Wing with a few spots, cells r_{4+5} with 3, cell m_{3+4} with 1 near the fork and cell an with 1 irregular markings. Squama with 18-19 setae. Haltere light brown with 4-5 setae. CR 0.95; VR 1-07.

Legs: Yellow to pale brown. Fore tibia with a blunt scale (fig. 42) bearing 2 long setae. Mid tibia with single spur 0.021 long, ratio of length of spur to the apical diameter of mid tibia 7 : 13; hind tibia with single spur 0.024 long, ratio of length of spur to the apical diameter of hind tibia 8 : 15. Femur of fore, mid and hind leg brown; tarsomere V of fore leg brown, other yellow. Sensilla chactica indistinguishable. Pulvilli moderately developed. Proportions and ratio of leg-segments in table 1.

Abdomen: Brown. Hypopygium (fig. 43) with slender apically knobbed anal point 0.036 long with 3-4 basolateral setae. Gonocoxite with 9-10 setae; gonostylus stout with rounded apex bearing 12-13 setae along its inner apical margin and 9-10 setae over it. Superior volsella stout, bent bearing 3 basal setae; inferior volsella well developed bearing 1 long apical seta and 11-12 incurved setae near apex. Transverse sternapodeme 0.054, lateral sternapodeme 0.108, coxapodeme 0.045 and phallapodeme 0.075 long. HV 0.875; HR 3.12.

Female. – Body 3.49 (3.23-3.58, n = 11) long, wing 1.62 (1.60-1.65, n = 12) long and 0.48 (0.48-0.50, n = 12) wide.

Similar to male with usual sex differences. Antenna (fig. 44) yellow, flagellomere V brown, ratio of flagellomere length I-V: 18 : 17 : 20 : 19 : 39, AR 0.53. Genitalia (fig. 45) with notum 0.093 long. Coxosternapodeme short. Gonapophysis VIII (fig. 46) divided into long dorsomesal lobe and stout ventrolateral lobe; apodeme lobe weak. Postgenital plate V-shaped. Cerci well developed and finely setose. Seminal capsules equal, almost rounded 0.042 in diameter, ducts of seminal capsules without any loop, opening separately into the vagina.

Pupa. – Brown. Exuviae pale brown. Body 4.44 (4.34-4.52, n = 8) long in male and 3.89 (3.80-3.96, n = 8) long in female.

Cephalothorax: Brown. Frontal apotome (fig. 47) with conical, apical bent cephalic tubercles, 0.13 long and 0.10 diameter at base, subapical frontal seta 0.12 long. Antennal sheath in male (fig. 48) 0.91 long, in female (fig. 49) 0.62 long. Thorax

rugose; wing sheath 1.05 long; thoracic horn (fig. 50) with an oval base 0.036 wide and a bunch of finely branched filaments. 2 pairs of precorneal setae.

Abdomen (fig. 51): Brown. Pedes spurii A caudolateral on segment V-VIII, not pronounced in segment VII, pedes spurii B caudolateral on segment II and basolateral on segment I. Tergite I bare, tergite II (fig. 52) with broad median patches of shagreen and a caudal transverse row of 32-41 hooklets; tergites III-IV with a narrow caudal and median irregular patches of shagreen; tergite V with median irregular patches of shagreen; tergite VI with a basal, narrow median and caudal transverse patches of shagreen, tergites VII-IX with 2 basal patches of shagreen. Segments II-VIII with 4, 3, 6, 6, 5, 6, 2 pairs of dorsal setae and segments II-VIII with 3, 2, 3, 3, 3, 4, 4 pairs of lateral setae, on segment V-VIII filamentous; segment VIII with 1 pair of caudolateral spurs (fig. 55) 0.18 long, each with 9-11 stout spines. Anal fin (fig. 51) 0.23 long with numerous filamentous setae. Genital sac in male (fig. 53) 0.20 long, in female (fig. 54) 0.22 long. G/F 0.87 in male and 0.96 in female.

Fourth instar larva. – Colouration dark red. Exuviae pale. Head capsule, claws of anterior and posterior parapods, and anal setae brown. Body 6.41 (6.29-6.55, n = 12) long.

Head: Brown. Occipital margin dark brown. Ventral head capsule (fig. 56) 0.27 long and 0.20 wide. Two eye spots, dorsal one slightly larger than ventral. Antenna (fig. 57) six-segmented, basal antennal segment 0.03 long and 0.012 wide, with a ring organ 0.003 in diameter, distance to ring organ from base 0.018 long; blade of basal antennal segment 0.054 long; accessory blade 0.012 long; Lauterborn organ two, first on antennal segment II being 0.012 long and second on segment III being 0.003 long; ratio of antennal segment length I-V: 10 : 3 : 4 : 1.5 : 4 : 1; AR 0.74. Labral lamella rod shaped with median pouch; S I (fig. 58) leaf like with serrated margin 0.021 long, between the bases of two S I 0.016 long; S II also leaf like 0.015 long; S III short with prominent base; S IV simple; S V minute; 4 chaetae; 2 spinulae; 4 chaetulae laterales; chaetulae basales absent. Pecten epipharyngis (fig. 59) comprising 3 toothed plates, median with 3 and each lateral with 8 teeth. Premandible (fig. 60) 0.054 long with 2 unequal, blunt apical teeth and 1 small inner tooth, premandibular brush dense. Mandible (fig. 61) 0.09 long with 1 apical and 3 inner teeth, first one smaller than others; seta subdentata 0.027 long; seta interna with 2 main plumose branches, one longer than the other; 2 seta externa; pecten mandibularis unmarked; ring organ 0.004 in diameter, very close to the base. Maxilla with blade like anterior chaeta; roughly pointed lacinial chaetae; antaxial seta and paraxial seta well

developed; sensillum basiconica 1; pecten galearis distinct; maxillary palp 3 segmented; first segment of maxillary palp 0.014 long, 0.012 wide, ring organ 0.082 in diameter, 4 setae maxillaris, SM₁ and SM₂ close to the palpiger, SM₃ and SM₄ close together on the sclerite of cardo. Prementohypopharyngeal complex (fig. 62) with prementum 0.021 wide, median lamella distinct, paramedian lamella indistinct, 4 sensilla and 6-7 chaetulae. Mentum (fig. 63) 0.048 long and 0.075 wide with a trifid median tooth 0.018 long and 0.021 wide; 6 pairs of lateral teeth, size gradually decreases from 1st lateral to the 4th, 5th long 6th short. Ventromental plate (fig. 64) fan-shaped 0.057 wide with distinct rays ending before the margin. V/M 2.71.

Abdomen: Dark red. Procerus 0.018 long, 0.027 wide at base, each with 8 anal setae 0.31 long and 2 short lateral setae. 2 supraanal setae, 0.29 long; Sa/An 0.93. Anterior parapods with numerous weakly sclerotised claws. Posterior parapods (fig. 65) 0.09 long with 15-16 well sclerotised variable claws (fig. 66). Anal tubules (fig. 65) conical 0.05 long.

40. *Xenochironomus flaviventris* (Kieffer)

Chironomus flaviventris Kieffer, 1911: 139.

Xenochironomus flaviventris (Kieffer): Chaudhuri & Guha 1987: 29.

Material examined. - 1 ♂, Farakka, 29 September 1986; 1 ♂ Hooghly, 4 September 1987; 4 ♂, 6 ♀, Naihati, 16 September 1987; 1 ♂ paratype (Z.S.I. Regn. No. 9731/19), India, Orissa, Puri, 20-21 January 1908, leg. N. Anandale.

Distribution. - India.

Differential diagnosis. - i) frontal tubercles absent, ii) scutellum with 12-13 setae in a row, iii) brachiolum with 3 setae, iv) colour pattern of leg, v) tergites with dark stripes, vi) anal point short, broad and dark brown, vii) superior volsella lobe like, setose and viii) inferior volsella long and dark brown.

Remarks. - The adult male was described by Kieffer (1911) in the genus *Chironomus* Meigen from Puri, India. On examining a paratype specimen from NZC, Calcutta, Chaudhuri and Guha (1987) placed this species in the genus *Xenochironomus* Kieffer. Reexamination of this paratype and a comparison with specimens from rice fields of Gangatic West Bengal confirm its generic position.

41. *Cladotanytarsus conversus* (Johannsen)

Tanytarsus conversus Johannsen, 1932: 543.

Cladotanytarsus conversus; Sublette & Sublette 1973: 416.

Material examined. - 8 ♂, Kalyani, 25 October 1986.

Distribution. - South Sumatra and India (present record).

Differential diagnosis. - i) frontal tubercles small, ii) scutellum with 8-10 irregular setae, iii) pulvilli very small, iv) tergites I-VII brown at lateral and caudal margin and v) anal point short without punctures.

42. *Cladotanytarsus gloveri* Ghosh & Chaudhuri

Cladotanytarsus gloveri Ghosh & Chaudhuri, 1983: 126.

Material examined. - 4 ♂, Burdwan, 14 September 1986; 3 ♂, Chinsura, 6 February 1987.

Distribution. - India.

Differential diagnosis. - i) frontal tubercles small, ii) scutellum with 6 setae, iii) haltere with 4-7 setae, iv) tergites I-VI brown at their caudal margin and v) anal point with 6-8 punctures.

43. *Cladotanytarsus multispinulus* Guha, Das, Chaudhuri & Choudhuri

Cladotanytarsus multispinulus Guha, Das, Chaudhuri & Choudhuri, 1985: 31.

Material examined. - 9 ♂, Kalyani, 17 February 1987; 2 ♂, Uttarpara, 24 February 1987; 3 ♂ Burdwan, 6 September 1987.

Distribution. - India.

Differential diagnosis. - i) frontal tubercles absent, ii) scutellum with 4 setae, iii) tergites I-V whitish with a yellowish apical band, tergites VI-VIII dark yellow and iv) anal point small with numerous spinules.

44. *Tanytarsus bifurcus* Freeman

Tanytarsus bifurcus Freeman, 1958: 337; Freeman & Cranston 1980: 221; Chaudhuri et al. 1984: 33; Chaudhuri & Guha 1987: 29.

Material examined. - 5 ♂, Farakka, 29 September, 1986.

Distribution. - Africa (Upper Volta) and India.

Differential diagnosis. - i) corona with setae, ii) scutellum with 6 setae, iii) haltere bare and iv) anal point stout with bifurcated apex.

45. *Tanytarsus commoni* Glover

Tanytarsus commoni Glover, 1973: 458.

Tanytarsus tamakutibasi Sasa, 1983: 22. *Syn. n.*

Material examined. - 6 ♂, Kalyani, 25 October 1986; 1 ♂ paratype (Aust. Nat. Ins. Coll., Australia), Clyde Mtn., Eastern foothills, 40 ft. N.S.W., 15 August 1967, leg. Z. Liepa.

Distribution. - Australia, Japan and India (present record).

Differential diagnosis. - i) frontal tubercles oval, ii) prescutellar 1, iii) pulvilli absent, iv) anal point

with 4 lateral setae and a subterminal oval lobe bearing 5 spinulae and v) median volsella small brush like.

Remarks. – A study of a male paratype from ANIC, Australia and a comparison with the present ones from rice fields confirm the conspecificity.

46. *Tanytarus fuscimarginalis* Chaudhuri, Guha & Ghosh

Tanytarus fuscimarginalis Chaudhuri, Guha & Ghosh, 1984: 33-34; Chaudhuri & Guha 1987: 30.

Material examined. – 4 ♂, Kalyani, 10 February 1986; 5 ♂, Uttarpara, 24 February 1987.

Distribution. – India.

Differential diagnosis. – i) scutellum with 4 setae, ii) wing white with yellowish tinge, iii) haltere setose, iv) abdominal tergites brown at the caudal and lateral margins and v) hypopygium with anal point bearing 5-7 punctures in a row.

47. *Tanytarsus vinculus* Chaudhuri, Guha & Ghosh

Tanytarsus vinculus Chaudhuri, Guha & Ghosh, 1984: 34; Chaudhuri & Guha 1987: 30.

Material examined. – 7 ♂, Howrah, 4 September 1987.

Distribution. – India.

Differential diagnosis. – i) corona bare, ii) frontal tubercles present, iii) haltere bare, iv) tergite I with a basal brown band, others with similar band at the caudal margin and v) hypopygium with anal point bearing 4 punctures in a row; median volsella brush-like with 8-10 unbranched setae.

48. *Clinotanypus fuscosignatus* (Kieffer)

Procladius fuscosignatus Kieffer, 1910: 218.

Clinotanypus fuscosignatus; Sublette & Sublette 1973: 390.

Material examined. – 5 larvae, Howrah, 4 September 1987; 5 larvae, 8 ♂ and 8 ♀ pupae, 6 ♂ and 5 ♀ exuviae, 7 ♂, 10 ♀, all reared; 2 ♂, Bally, 8 March 1987; 1 ♂, Burdwan, 6 September 1987.

Distribution. – Bangladesh and India.

Differential diagnosis. – Larva: i) high value of AR (15.2), ii) chaetulae laterales and chaetulae basales indistinct, iii) middle two teeth of ligula small and equal, iv) paraligula with 3 points on inner side and 2 points on outer side and v) mentum with 14-15 dorsomental teeth on each side in two rows.

Pupa: i) frontal apotome without cephalic tubercles and frontal setae, ii) thoracic horn with short neck and broad plastron plate, iii) segments I-VII with 2, 1, 3, 3, 3, 3, 6 pairs of dorsal setae, iv) lateral setae on segments VII and VIII simple and v) G/F 0.43 in male and 0.39 in female.

Adult: i) corona with 4 setae, ii) frontal tubercles absent, iii) mesonotum with 6 bands, iv) scutellum with 40-42 long setae in two rows and numerous small setae, v) pattern of wing markings, vi) banding pattern of abdomen and vii) tibial spurs with 5 teeth.

Remarks. – The adults of both sexes of *Procladius fuscosignatus* were first described by Kieffer (1910) from Calcutta, India. Sublette & Sublette (1973) transferred it to *Clinotanypus* Kieffer. Study of type specimens from NZC, Calcutta and comparison with material reared in the laboratory confirm the validity of the species and the combination suggested by Sublette & Sublette (1973).

Redescription

Adult. – Male: Body 4.07 (3.99-4.14, n = 10) long, wing 2.25 (2.23-2.27, n = 10) long and 0.91 (0.90-0.92, n = 10) wide.

Head: Reddish brown. Vertex with 27-29 setae (IV 3-4, OV 6, PO 18-19). Corona with 4 setae. Clypeus with 14-16 setae, clypeal ratio 1.66. Maxillary palp pale brown, ratio of palpomere length I-V: 6 : 10 : 40 : 5 : 70; L/W 3.07. Eyes reniform with a dorsal extension of 0.08 long. Frontal tubercles absent. Antenna brown, ratio of flagellomere length I-XI: 12 : 9 : 10 : 10 : 9 : 8 : 10 : 8 : 9 : 8 : 8 : 8 : 260 : 50; AR 2.81; pedicel ratio 1.0. CA 0.47; CP 1.11.

Thorax: Shiny light brown. Antepronotum well developed, antepronotals 10. Mesonotum with 3 pairs of bands in antero-median, postero-lateral and prescutellar region. Acrostichals 20-21 irregularly biserial, dorsocentrals 21-23 irregularly biserial, humerals 11, prescutellars 30-32, prealars 23-30 in a staggered row. Scutellum shiny with 40-42 setae in two rows at the posterior margin in addition to numerous irregular small setae, postsutellum dark brown except the upper end bearing 30-32 setae.

Wing (fig. 67): Smoky and distal third hyaline. Brachiolum with 3-4 setae and 26-30 sensilla componiformia. Costa extended a little being 0.08 long, R_1 shortly bifurcated at the tip; RM thickened, moderately oblique; MCu proximal to RM; RM slightly proximal to FCu. Wing with characteristic bands and spots; dark brown transverse band across distal half from R_1 to twothird of cell m being interrupted in cell r_{4+5} , a large square brown spot over RM. Squama with 29-31 setae, haltere pale with 6-8 setae. CR 0.97; VR 1.07.

Legs: Yellow. Femora of all legs and fore tibia with a basal and apical, mid tibia with only basal and hind tibia with basal and apical dark brown bands. Fore tibia with single spur (fig. 68) 0.054 long having 9-10 small weak lateral teeth, ratio of length of spur to the apical diameter of fore tibia 18 : 25; spurs of mid tibia (fig. 69) unequal, 0.042 and 0.051 long, each having 5 lateral teeth, ratio of length of

spurs to the apical diameter of mid tibia 14 : 24 and 17 : 24; spurs of hind tibia also unequal, 0.048 and 0.081 long, each with 5 lateral teeth, ratio of length of spurs to the apical diameter of hind tibia 16 : 30 and 27 : 30. Hind tibial comb with 13 setae each. Tarsomeres IV-V entirely brown. Proportions and ratios of leg-segments in table 1.

Abdomen (fig. 70): Yellowish brown. Tergites II-VII with transverse brown bands and tergites V and VIII with very narrow transverse brown bands. Tergite IX with 22-23 setae. Hypopygium (fig. 71) with triangular anal point. Gonocoxite 0.24 long, broad proximally and narrow distally; gonostylus (fig. 72) 0.15 long, distal part with 5 setae, curved at right angle to the base and with a subapical tooth. HR 1.6; HV 2.66.

Female. – Body 2.92 (2.65-3.24, n = 4) long, wing 2.19 (2.03-2.37, n = 6) long and 0.86 (0.83-0.98, n = 6) wide.

Similar to male with usual sex differences. Antenna brown with 14 flagellomeres, flagellomere II almost twice as long as broad, flagellomere III-XIV globular, flagellomere XV elongated, somewhat elliptical. Thoracic and leg colouration darker than in male. Genitalia (fig. 73) with notum 0.22 long. Coxosternapodeme curved, thickened and broad proximally. Gonapophysis VIII triangular. Postgenital plate semicircular. Cerci 0.105 long and finely setose. Seminal capsules 3, approximately equal, balloon shaped, ducts of seminal capsules without any loop, opening separately into the vagina.

Pupa. – Brown. Exuviae pale. Body 4.72 (4.66-4.79, n = 8) long in male and 4.97 (4.91-5.07, n = 8) long in female.

Cephalothorax: Dark brown. Frontal apotome (fig. 74) without cephalic tubercles and frontal setae. Antennal sheath in male (fig. 75) 1.09 long, in female (fig. 76) 0.63 long. Thorax rugose; wing sheath 1.69 long; thoracic horn (fig. 77) 0.4 long with short neck and broad plastron plate, having straight basal edge.

Abdomen (fig. 78): Brown. Segments II-VIII with 1, 1, 1, 1, 1, 7, 5 pairs of lateral setae and segments I-VII with 2, 1, 3, 3, 3, 3, 6 pairs of dorsal setae; all setae branched except lateral long setae on segments VII and VIII. Anal fin (fig. 78) 0.71 long with 2 pairs of long filamentous setae. Genital sac in male (fig. 79) 0.31 long, in female (fig. 80) 0.28 long; G/F 0.43 in male and 0.39 in female.

Fourth instar larva. – Colouration light brown, exuviae paler. Head capsule, claws of anterior and posterior parapods, and anal setae brown. Body 7.55 (7.32-7.67, n = 10) long.

Head: Brown. Occipital margin pale. Ventral head capsule (fig. 81) 0.67 long. One eye spot, re-

niform. Antenna (fig. 82, 83) four-segmented, basal antennal segment 0.43 long with a ring organ 0.004 in diameter, distance to ring organ from base 0.39; blade of basal antennal segment 0.036 long; accessory blade 0.015 long; blade of antennal segment II 0.021 long; Lauterborn organs 2, very small; ratio of antennal segment length I-IV: 144 : 7 : 1.5 : 1; AR 15.2. S I simple 0.018 long, between the bases of two S I 0.021 long; S II-III simple; S IV indistinct; 2 chaetae; 3-4 spinulae; chaetulae laterales and chaetulae basales indistinct. Mandible (fig. 83) 0.129 long with expanded base on inner side, apical tooth dark and strongly hooked, lateral teeth 4; first lateral tooth large, pointed apically; others small; seta subdentalis distinct; 3 seta externa; ring organ 0.003 in diameter, distance of ring organ from base 0.006. Maxilla (figs. 85, 86) developed, maxillary palp 3 segmented, first segment of maxillary palp 0.066 long with a ring organ 0.003 in diameter; segment II hyaline and 4-5 sensilla at its apex. Prementohypopharyngeal complex well developed; ligula (fig. 87) with 6 teeth, middle two small and equal; paraligula (fig. 87) with 3 points on inner side and 2 points on outer side. Mentum (fig. 88) with 14-15 light brown dorsomental teeth on each side laterally in double row; M appendage (fig. 88) with distinct, granulose pseudoradula, labial vesicles absent.

Abdomen: Light brown. Procerus 0.165 long and 0.054 wide, each with 15-16 anal setae 0.658 long and 2 small lateral setae. 2 supraanal setae 0.53 long; Sa/An 0.808. Anterior parapods with numerous weakly sclerotised claws. Posterior parapods (fig. 89) 0.434 long with 14-15 sclerotised variable claws (fig. 90). Anal tubules (fig. 89) conical, 0.21 long.

49. *Procladius noctivagus* (Kieffer)

Tanypus noctivagus Kieffer, 1919: 222.

Procladius noctivagus; Freeman 1955c: 59; Freeman & Cranston 1980: 177; Chaudhuri & Debnath 1983: 121 (as subgenus).

Trichotanypus niloticus Kieffer, 1923: 189.

Trichotanypus nilicola Kieffer, 1925: 309.

Material examined. – 5 larvae, Kalyani 10 February 1986; 3 larvae, 9 ♂ and 9 ♀ pupae, 4 ♂ and 6 ♀ exuviae, 7 ♂, 8 ♀, all reared; 1 ♂, Burdwan, 29 January 1986.

Distribution. – Chad, Egypt, India, Niger, Nigeria and Sudan.

Differential diagnosis. – Larva: i) AR 4.0, ii) mandible with 2 minute elevations at the inner apical margin, iii) ligula with 5 dark teeth, middle one shortest, iv) paraligula with 4 points on inner side and 7 points on outer side, v) mentum with 8 dorsomental teeth on each side and vi) M appendage with bulb like labial vesicles.

Pupa: i) thoracic horn linear with oval plastron plate, ii) tergites I and III bare, iii) segments I-VIII

with 3, 2, 2, 6, 5, 5, 5, 2 pairs of dorsal setae and iv) G/F 0.44 in male and 0.4 in female.

Adult: i) frontal tubercles absent, ii) scutellum with 20-24 irregular setae, iii) haltere yellow with 6-7 setae, iv) tibial spurs with 4 teeth, v) hind tibial comb with 11 setae, vi) banding patterns of abdomen and vii) gonostylus small, heel prominent and having a sharp tooth.

Remarks. – The analysis of characters of both immatures and adults reconfirm its systematic position.

Redescription

Adult. – Male: Body 3.61 (3.51-3.68, n = 8) long, wing 1.57 (1.55-1.58, n = 8) long and 0.53 (0.53-0.55, n = 8) wide.

Head: Brown. Vertex with 25-26 setae (IV 3-4, OV 12, PO 10). Corona with 4 setae. Clypeus with 16 setae, clypeal ratio 0.57. Maxillary palp dark brown, ratio of palpalomere length I-V: 4 : 5 : 7 : 12 : 20; L/W 2.33. Eyes reniform with dorsal extension of 0.09. Frontal tubercles absent. Antenna brown, ratio of flagellomere length I-XIV: 2 : 3 : 4 : 5 : 5 : 5 : 6 : 6 : 6 : 8 : 8 : 102: 28; AR 2.13; pedicel ratio 1.0. CA 0.24; CP 0.91.

Thorax: Yellowish brown. Antepronotum with a dorsal emargination in middle, antepronotals 6. Mesonotum with 3 light brown vittae. Acrostichals 36-40 irregularly biserial and diverging posteriorly, dorsocentrals 15 uniserial, humerals 5, prescutellars 6, prealars 10. Scutellum with 20-24 irregular setae, postscutellum dark brown and bare.

Wing ((fig. 91): Wing membrane clothed with macrotrichia. Brachiolum with 2 setae and 19-21 sensilla campaniformia. Costa extended, extension 0.12 long. Wing with spots at the fork of R, cell r_{4+5} , cell m, cell m_{3+4} and cell an; RM clouded and base of MCu thickened, RM oblique, MCu below RM. Squama with 23-25 setae. Haltere yellow with 6-7 setae. CR 0.95; VR 1.45.

Legs: Yellowish brown. Femora yellow, apex of tibia dark. Fore tibia with a spur (fig. 92) 0.062 long with 4 lateral teeth, ratio of length of spur to the apical diameter of fore tibia 12 : 14; spurs of mid tibia (fig. 93) subequal, 0.031 and 0.04 long, each with 4 lateral teeth, ratio of length of spurs to the apical diameter of mid tibia 8 : 13 and 10 : 13; spurs of hind tibia unequal, 0.03 and 0.05 long, each with 4 lateral teeth, ratio of length of spurs to the apical diameter of hind tibia 8 : 13 and 10 : 13; spurs of hind tibia unequal, 0.03 and 0.05 long, each with 4 lateral teeth, ratio of length of spurs to the apical diameter of hind tibia 8 : 16 and 15 : 16. Apex of tarsomeres I-III narrowly darkened, tarsomeres IV-V uniformly brown. Mid and hind tarsomeres I-II with single spur 0.031 long. Hind tibia comb (fig. 94) with 11 setae. Pulvilli absent. Proportions and ratios of leg-segments in table 1.

Abdomen (fig. 95): Yellow. Tergites with a basal transverse dark brown band, tergites V-VIII mostly dark with pale caudal area. Hypopygium (fig. 96) with scale like anal point. Gonocoxite stumpy,

broad at the base and narrow distally; gonostylus small, heel prominent and having a sharp tooth. Apodemes well developed. HR 2.44; HV 3.58.

Female. – Body 2.56 (2.51-3.02, n = 8) long, wing 1.71 (1.68-1.74, n = 8) long and 0.66 (0.62-0.68, n = 8) wide.

Similar to male with usual sex differences. Antenna brown, ratio of flagellomere length I-XIII : 6 : 6 : 6 : 6 : 6 : 6 : 5 : 5 : 5 : 7 : 26; AR 0.37. Genitalia (fig. 97) with notum 0.18 long. Coxosternapodeme curved. Gonapophysis VIII triangular with a fold. Postgenital plate developed. Cerci finely setose. Seminal capsules 3, approximately equal, ovoid 0.07 long by 0.06 wide; duct of seminal capsules without any loop, opening separately into the vagina.

Pupa. – Brown. Exuviae white. Body 3.19 (3.09-3.26, n = 9) long in male and 3.49 (3.39-3.51, n = 9) in female.

Cephalothorax: Brown. Frontal apotome (fig. 98) without cephalic tubercles and frontal seta. Antennal sheath in male (fig. 99) 0.74 long, in female (fig. 100) 0.48 long. Thorax rugose; wing sheath 0.89 long; thoracic horn (fig. 101) linear, 0.28 long with oval plastron plate and distinct neck.

Abdomen (fig. 102): Brownish yellow. Tergites I and III bare; tergite II and tergites IV-VIII with median shagreen. Segments I-VIII with 3, 2, 2, 6, 5, 5, 5, 2 pairs of dorsal setae and segments II-VII with 2, 2, 1, 1, 1, 4, 4 lateral setae, on segmentous VII-VIII filamentous. Anal fin (fig. 102) 0.35 long with 2 pairs of filamentous setae. Genital sac in male (fig. 103) 0.15 long, in female (fig. 104) 0.14 long, G/F 0.44 in male and 0.4 in female.

Fourth instar larva. – Brownish yellow. Exuviae white. Head capsule, claws of anterior and posterior parapods and anal setae brown. Body 4.61 (4.54-4.69, n = 8) long.

Head: Brown. Occipital margin dark brown. Ventral head capsule (fig. 105) 0.39 long and 0.38 wide. One eye spot, almost reniform. Antenna (fig. 106) four-segmented, basal antennal segment 0.096 long and 0.21 wide at base with a ring organ 0.004 in diameter, distance to ring organ from base 0.069; blade of basal antennal segment 0.018 long; accessory blade 0.004 long; blade of antennal segment II 0.0015 long, 1 pair of minute Lauterborn organ; ratio of antennal segment length I-IV: 32 : 5.5 : 1.5 : 1; AR 4.0. Labral lamella more or less triangular. S I blade like 0.015 long; S II tubular with an apical setae, S III and S IV minute; 1-2 chaetae; 2 spinulae; chaetulae laterales and chaetulae basales absent. Mandible (fig. 107) 0.111 long with 1 dark apical tooth, 1 prominent basal tooth and 1 conical tooth at the base of apical tooth; seta subdentalis 0.015 long; 3 seta externa; inner margin with 2

minute elevations at the apical portion. Maxilla (fig. 108) developed, maxillary palp 3.0.042 long with a ring organ 0.0015 in diameter and 5-6 sensilla at its apex; 2 setae maxillaris; SM₁ and SM₂ close to the stipes.

Prementohypopharyngeal complex well developed; ligula (fig. 109) with 5 dark teeth, middle one shortest; paraligula (fig. 109) with 4 points on inner side and 7 points on outer side. Mentum (fig. 110) with 8 brown dorsomental teeth on each side, outer one smallest; M appendage (fig. 110) with bulb like labial vesicles, pseudoradula distinct.

Abdomen: Brownish yellow. Procerus 0.14 long and 0.039 wide, each with 14-15 anal setae 0.532 long and 2 small lateral setae. 2 supraanal setae 0.392 long, Sa/An 0.74. Anterior parapods with numerous weekly sclerotised claws, posterior parapods (fig. 111) 0.36 long with 14-15 sclerotised variable claws (fig. 112). Anal tubules (fig. 111) conical 0.25 long.

50. *Tanypus bilobatus* (Kieffer)

Procladius bilobatus Kieffer, 1913b: 155.

Tanypus bilobatus; Chaudhuri, Nandi & Ghosh 1983: 122-133; Chaudhuri & Guha 1987: 25.

Material examined. - 6 larvae, Burdwan, 30 May 1986; 9 larvae, 6 ♂ and 6 ♀ pupae, 6 ♂ and 5 ♀ exuviae, 5 ♂, 5 ♀, all reared; 3 ♂, Naihati, 16 September 1987; 4 ♂, Hooghly, 4 September 1987.

Distribution. - India.

Differential diagnosis. - i) larval antenna only about one-third of the head length, middle tooth of ligula as long as those of lateral, number of teeth in paraligula and shape of mentum, ii) pupa with biconvex thoracic horn and transparent frontal apotome without cephalic tubercle, frontal setae 1 pair, iii) adult with setose haltere, rounded anal lobe, MCu proximal to FCu distance between MCu and base of FCu less than one-third as long as Cu₁, tarsomere V uniformly brown and wing with numerous spots or bands.

Remarks. - On examination of the type specimens present at the NZC, Calcutta and correlating them with the collected and reared material, Chaudhuri et al. (1983) recombined this species with the genus *Tanypus*.

51. *Tanypus grandis* Chaudhuri, Das & Debnath

Tanypus grandis Chaudhuri, Das & Debnath, 1984: 100; Chaudhuri & Guha 1987: 25.

Material examined. - 10 ♂, Kalyani, 21 August 1986.

Distribution. - India.

Differential diagnosis. - i) large size, ii) linear brown streak near the base of cell r and m, iii) spots near the margin of cell m beyond MCu, cell m₃₊₄

with two rounded spots, near its distal margin, iv) tergites with dorsomedian dark patches, v) chaetotaxy of thorax and vi) gonostylus with prominent carina.

52. *Tanypus lucidus* Chaudhuri, Das & Debnath

Tanypus lucidus Chaudhuri, Das & Debnath, 1984: 103; Chaudhuri & Guha 1987: 25.

Material examined. - 4 ♂, Bally, 13 February 1986; 8 ♂, Burdwan 7 September 1987.

Distribution. - India.

Differential diagnosis. - i) scutellum with 30-32 setae, ii) brachiolum with 1 seta, iii) squama with 31 setae, iv) tibia uniformly brown and hypopygium without anal point or with membranous structure, v) hind tibial comb with 5 setae and vi) cell r without any markings.

53. *Tanypus tenebrosus* Chaudhuri, Das & Debnath

Tanypus tenebrosus Chaudhuri, Das & Debnath, 1984: 105; Chaudhuri & Guha 1987: 25.

Material examined. - 5 ♂, Naihati, 16 September 1987.

Distribution. - India.

Differential diagnosis. - i) brachiolum with 2 setae, ii) haltere brown with 4 setae, iii) tarsomeres uniformly brown, iv) hind tibial comb with 9 setae, v) tergites I-V with mid lateral stripe, tergites VI-VIII with only middle stripe and vi) gonostylus small, bent ending in an apical tooth.

BIOLOGY

Almost all the rice fields of West Bengal are polluted. Chironomid larvae accumulate either by eggs deposited there or are carried to the field with incoming water from various sources. At the beginning of the rice season, the fields are muddy and studded with larval tubes of chironomids belonging to the genus *Chironomus*. In the middle of the season larvae of *Chironomus* were seen to live there in association with algal mats. All the species of chironomid larvae, except for the predaceous forms belonging to the genera *Clinotanypus*, *Tanypus* and *Procladius*, constructed tubular houses. The tubes were mostly 'U'-shaped or 'S'-shaped in *Chironomus* and *Kiefferulus* and sometimes tunnel-like in the mud. The houses of *Polypedilum* and *Stictochironomus* were usually slender and 'U'-shaped, but conical tubes appeared at lower depths than in *Chironomus*. The nests of *Dicrotendipes* were smaller than those of *Chironomus*. The tubes built by the larvae of *Tanytarsus* were distinguished into two types, long cylindrical, or upright tubes over or just beneath the mud surface in winter and branched in

Table 2. Duration of life history stages in summer ($32 \pm 2.5^\circ\text{C}$) and winter ($24 \pm 2.5^\circ\text{C}$); a = summer, b = winter.

Species		Egg (hrs)	Larval duration (days)	Pupa (hrs)	Adult (days)	Total (days)
<i>Chironomus samoensis</i>	a	34-50	16-25	24-28	2-3.5	20.42-31.75
	b	52-74	24-36	27-38	3-4.5	30.29-45.17
<i>Dicrotendipes pelochloris</i>	a	30-54	20-29	24-48	2-4	24.25-37.25
	b	36-71	25-40	34-56	3-4	30.92-49.29
<i>Stictochironomus obscurum</i>	a	30-42	20-26	21-29	2-3	24.12-31.96
	b	46-73	21-28	26-36	3-4	27.00-36.54
<i>Clinotanypus fuscosignatus</i>	a	-	-	-	-	-
	b	59-90	64-72	51-65	3-4	71.58-82.46
<i>Procladius noctivagus</i>	a	52-84	45-50	46-56	1-3	50.08-59.25
	b	64-88	55-68	59-75	2-3	62.12-77.79

the summer and remaining in the deeper layer of substrates.

It was observed that the larvae of *Chironomus samoensis* and *Kiefferulus barbatitarsis* prefer to remain in clumped conditions in association with the roots of the rice plants. It seems interesting that the larvae of *Cryptochironomus judicius* made their abodes on the side walls of the rice fields, whereas there was no trace of the larvae within the rice fields. It may be thought that *Tanypus* larvae were dominant in the early crop season whereas the larvae of *Clinotanypus* dominated in the late season. In contrast to the observations of Ping (1917) and Darby (1962), larvae of *K. barbatitarsis* survived in most cases for almost one month out of water, but the remaining larvae died after four to five days under such conditions.

The present study details the life history of 5 species: *Chironomus samoensis* Edwards, *Dicrotendipes pelochloris* (Kieffer), *Stictochironomus obscurus* (Guha & Chaudhuri), *Clinotanypus fuscosignatus* (Kieffer) and *Procladius noctivagus* (Kieffer). The duration of egg, larva, pupa and imago in both summer ($32 \pm 2.5^\circ\text{C}$ temperature and 51-76% humidity) and winter ($24.5 \pm 2.5^\circ\text{C}$ temperature and 20-48% humidity) are shown in table 2.

EMERGENCE AND SEX RATIO

Emergence of adult chironomids was studied in the laboratory in both summer ($32 \pm 2.5^\circ\text{C}$) and winter ($24.5 \pm 2.5^\circ\text{C}$). The emergence period appeared to be related to the duration of the larval period. *Chironomus samoensis* emerged in the evening hours, i.e. at dusk. The emergence period in winter was 1-2 hours earlier than in summer, which might be due to the change in the time of sunset. *Dicrotendipes pelochloris* and *Stictochironomus obscurus* emerged mostly throughout the day i.e.

dawn and dusk in summer. In winter maximum emergence occurred during the mid day except for *D. pelochloris* where it also continued in the afternoon, up to the early hours of darkness during several days of observations. *Procladius noctivagus* exhibited a bimodal pattern in summer, emerging in dawn and dusk with a few hours (1-2) earlier in winter. In winter, the emergence of *Clinotanypus fuscosignatus* began 2-3 hours prior to dawn and dusk with a peak of 1-1.5 hours after sunset.

It is evident here that the adult emergence of most chironomids showed an approximately diel periodicity and maximum emergence occurred mainly between late afternoon and early hours of darkness. The emergence pulse tended to be higher near the middle of the total emergence period.

Sex ratio in laboratory emergences (table 3)

The sex ratio of adults reared from egg masses in the laboratory was expressed in percentages of males, or females. The percentage of males was higher in *Chironomus samoensis* and *Stictochironomus obscurus*. On the other hand, females predominated in *Dicrotendipes pelochloris*, *Clinotanypus fuscosignatus* and *Procladius noctivagus*. Of the five species of chironomids studied here, the highest percentage of males was observed in *Stictochironomus obscurus* (65.55%) and of females in *Clinotanypus fuscosignatus* (67.07%).

DISCUSSION

Investigations represented in this paper comprise morphological diagnoses of 53 species of chironomids found in the rice paddies of West Bengal, India. Of these, 40 species are recorded as adults only and 13 including immature stages. Prior to this work, most of these were recorded from various places in India other than rice paddies. Further 10

Table 3. Numbers of larvae, pupae and adults reared from egg masses and sex ratios of emerged adults.

Species	No. of egg masses	No. of eggs	Larvae hatched	Percent- age of eggs hatched	Pupae obtained	Percent- age of larvae pupated	Adults emerged		Percent- age of pupae hatched	Sex ratios of adults (♂: ♀)
							Male	Female		
<i>Chironomus samoensis</i>	5	1024	799	78.03	293	36.67	109	61	58.02	64.12:35.88
<i>Dicrotendipes pelochloris</i>	4	682	374	54.84	168	44.92	49	68	69.64	41.88:58.12
<i>Stictochironomus obscurum</i>	5	1665	1199	72.01	423	35.28	177	93	63.83	65.56:34.44
<i>Clinotanypus fuscosignatus</i>	5	651	377	57.91	103	27.32	27	55	79.61	32.93:67.07
<i>Procladius noctivagus</i>	5	901	602	66.81	225	37.37	54	76	57.78	41.54:58.46

species were previously reported from Thailand (Hashimoto et al. 1981), six from Japan (Sasa & Kikuchi 1986) and one from North America (Darby 1962).

The life cycles of chironomids described here, present interesting features of the biology of the midges. The present work is the first attempt to study the life cycle of the following five oriental species from rice paddies: *Chironomus samoensis* Edwards, *Dicrotendipes pelochloris* Kieffer, *Stictochironomus obscurus* (Guha & Chaudhuri), *Clinotanypus fuscosignatus* (Kieffer) and *Procladius noctivagus* Kieffer. The duration of each stage was generally neglected in earlier works. It can only be conveniently determined in the laboratory, as did Hilsenhoff (1966). Grodhaus (1963) reported the life cycle of *Chironomus tentans* Fabricius on the basis of information from Sadler (1935). The duration of each stage is temperature-dependent and related to the overall length of the life cycle (Oliver 1971). The time required for hatching of eggs was recorded as 2.5 days at 24 °C in *Chironomus atrella* (Townes) by Anderson & Hitchcock (1968), 4 days at 20 °C in *C. zealandicus* Hudson by Forsyth (1971) and 4-5 days at 18 °C in some other species (Mundie 1956). Similarly the duration was recorded to be 3-4 days at 18 °C in *Einfeldia synchrona* Oliver (Danks 1971) and 2-2.5 days and 3-3.5 days at 32 ± 2.5 °C and 24.5 ± 3 °C respectively in *Tanypus bilobatus* (Kieffer) by Chaudhuri et al. (1983). Recently, Chaudhuri & Ghosh (1986) reported that the duration of egg stage required 40-60 hours and 48-72 hours in *Kiefferulus barbatitaris* and 24-36 hours and 48-69 hours in *K. calligaster* at temperatures of 32 ± 2.5 °C and 24.5 ± 3 °C respectively. Chattopadhyay et al. (1988) stated the duration in the case of *Polypedilum nubifer* to be 28-40 hours in summer (32 ± 2.5 °C) and 42-72 hours in winter (24 ± 2.5 °C). It may therefore be inferred that the hatching period varies with temperature, being shorter with the rise of temperature in summer and longer with the fall of temperature in winter.

The duration of the larval stages of four species, both in summer and winter and one species in winter only are presented in table 2. The larval stage of the members of Chironominae required 16-29 days and 20-40 days in summer and winter respectively, whereas tanypodid species needed 45-50 days and 55-72 days respectively. Oliver (1971) stated that changes in the duration of the larval period occur over a wide range of latitudes. With increasing latitude, the duration of the larval period became longer. Temperature was one of the main factors responsible for this increase. According to Jónasson (1965), *Chironomus anthracinus* Zetterstedt, was recorded to have a two year life cycle, although some emerged after one year and growth was reduced both in summer (related to low oxygen concentration) and in winter (related to low temperature). The 2-year life cycle in other species was also reported by Hamilton (1965) and Saether (1968). Butler (1982) reported a 7-year life cycle for two *Chironomus* species in arctic Alaskan tundra ponds. The processes involved in slowing down or cessation of growth and development have not received due attention. Developmental arrests with a cessation of feeding in both summer and winter were found by Hilsenhoff (1966), Jónasson & Kristiansen (1967) & Armitage (1970). From these studies, it became evident that temperature itself was not the factor which controlled larval life, it rather played a key role in determining the length of larval life, but other factors, particularly the availability of food, were also important (Jónasson 1965; Forsyth 1971).

The pupal stage had not been seriously investigated except for its taxonomic importance. As compared to the larval stage, the duration of the pupal stage is very brief, ranging from a few hours to a few days (Forsyth 1971, Oliver 1971, Chaudhuri et al., 1983, Chaudhuri & Ghosh 1986, Chattopadhyay et al. 1988) and temperature dependent (Mundie 1956; Hilsenhoff 1966), which is also confirmed by this investigation (table 2). The pupal life varied between 21-48 hours and 26-56 hours in Chirono-

mina and between 46-66 and 51-75 hours in Tany-podinae in summer and winter respectively.

The life span of adult chironomids lasts for a few days (Table 2), supporting Forsyth (1971) and Hein & Schmulbach (1972). The duration of adult life of one week (Mundie 1956) or several weeks (Oliver 1971) is more unusual.

The emergence period is related to the duration of the larval period (Chaudhuri et al. 1983). The adults are able to fly immediately after emergence as shown by Mundie (1956), Hilsenhoff (1956), Brundin (1966), Forsyth (1971) and Hein & Schmulbach (1972). The investigations revealed that the rate of emergence was highest during the middle of the total emergence period conforming the findings of Chaudhuri et al. (1983) & Chatto-padhyay et al. (1988). According to Ali (1980), the periodicity is caused by a complex interaction of various environmental stimuli and endogenous rhythms. The phenomenon appears to be typically regulated and maintained by an internal clock (the endogenous rhythms) which is said to be influenced by external stimuli or exogenous factors (Corbet 1964). Temperature is regarded as the more important factor determining diel emergence periodicities in high arctic chironomids (Oliver 1968; Danks & Oliver 1972). Similar observations are reported for mosquitoes by Corbet (1966). In contrast, intensity of light appears as the factor controlling the diel emergence pattern of chironomids in the temperate zones. This study revealed that *Chironomus samoensis* emerged at dusk in summer (see also Morgan & Weddell 1961), while a few emerged at dawn.

Dicrotendipes pelochloris and *Stictochironomus obscurus* did not show a distinct periodicity in emergence, occurring mostly throughout the day (Singh and Harrison 1982). A bimodal pattern was also found by Ali & Mulla (1979) & Ali (1980). However, a deviation was noticed in the peak of emergence related to the earlier onset of sunset in *Clinotanypus fuscognatus* as stated above. Light intensity may probably be the inducing agent in the emergence of *D. pelochloris* and *S. obscurus* as shown by Oliver (1968). Since these two environmental clues were immediately linked together, their combined effects require further investigation.

There are several reports on sex-ratios deviating from the normal 1 : 1. According to Palmén (1962) and Lindeberg (1971) males emerge in lower numbers than females. This investigation revealed a higher percentage of females in the case of *Dicrotendipes pelochloris*, *Clinotanypus fuscognatus* and *Procladius noctivagus* reared from egg masses (Table 3), as also was notified by Palmén (1962) and by Singh & Harrison (1982), but the reverse situation with a preponderance of males occurred in *Chironomus samoensis* and *Stictochironomus obscurus*, as was also found by Hein & Schmulbach

(1972), Chaudhuri et al. (1983) and Chattopadhyay et al. (1988). A rhythm in emergence starting with an excess of males and ending with female predominance was recorded in most of the chironomids in question, as shown by Miall & Hammond (1900) and Downes (1969), but no such rhythm was observed in *Stictochironomus obscurus* in the present study.

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REFERENCES

- Ali, A., 1980. Diel adult eclosion periodicity of nuisance chironomid midges of Central Florida. – Environmental Entomology 9: 365-370.
- Ali, A., P. K. Chaudhuri & D. K. Guha, 1987. Description of *Stictochironomus affinis* (Johannsen) (Diptera: Chironomidae), with notes on its behavior. – Florida Entomologist 70: 259-267.
- Ali, A. & M. S. Mulla, 1979. Diel periodicity of eclosion of adult chironomid midges in a residential recreational lake. – Mosquito News 39: 360-364.
- Anderson, J. F. & S. W. Hitchcock, 1968. Biology of *Chironomus atrella* in a tidal cove. – Annals of the entomological Society of America 61: 1597-1603.
- Armitage, P. D., 1970. The Tanytarsini (Diptera, Chironomidae) of a shallow woodland lake in South Finland, with special reference to the effect of winter conditions on the larvae. – Annales Zoologici Fennici 7: 313-322.
- Beck, W. M. & E. C. Beck, 1970. The immature stages of some Chironomini (Chironomidae). – Quarterly Journal, Florida Academy of Sciences 33 (1): 29-42.
- Becker, T., 1908. Dipteren der Kanarischen Inseln. – Mitteilungen aus dem Zoologischen Museum in Berlin 4: 1-180.
- Bognár, S., 1958. A rizs magyarországi izeltlábu (Arthropoda) Kártevőiről. (Arthropodal pests in rice fields in Hungary). – Növénytermelés 7: 143-152.
- Borkent, A., 1984. The systematics and phylogeny of the *Stenochironomus* complex (*Xestochironomus*, *Harrisius* and *Stenochironomus*) (Diptera: Chironomidae). – Memoirs of the Entomological Society of Canada 128: 1-269.
- Brundin, L., 1966. Transantarctic relationships and their significance, evidenced by chironomid midges. With a monograph of the subfamilies Podonominae and Aphroteniinae and the austral Heptaglyiae. – Kungliga Svenska Vetenskaps-akademiens Handlingar 11: 1-472.

Butler, M. G., 1982. A 7-year life cycle for two *Chironomus* species in arctic Alaskan tundra ponds (Diptera: Chironomidae). – Canadian Journal of Zoology 60: 58-70.

Chattopadhyay, S., T. Dutta & P. K. Chaudhuri, 1988. Morphology and biology of *Polypedilum nubifer* (Skuse) from India (Diptera: Chironomidae). – Journal of the Bengal Natural History Society 7 (2): 29-41.

Chaudhuri, P. K. & S. Chattopadhyay, 1988. Studies on the juveniles of *Microchironomus* from India (Diptera: Chironomidae). – Oriental Insects 22: 175-183.

Chaudhuri, P. K., S. K. Das & R. K. Debnath, 1984. Studies of Indian Tanypodinae (Diptera: Chironomidae). Genus *Tanyptus* Meigen. – Polskie Pismo Entomologiczne 55: 99-109.

Chaudhuri, P. K. & R. K. Debnath, 1983. Studies of Indian Tanypodinae (Diptera: Chironomidae), Genus *Procladius* Skuse. – Zoológische Jahrbücher, Systematik 110: 111-123.

Chaudhuri, P. K. & M. Ghosh, 1986. Two Indian species of *Kiefferulus* Goet. (Diptera: Chironomidae). – Systematic Entomology 11: 277-292.

Chaudhuri, P. K. & D. K. Guha, 1987. A conspectus of chironomid midges (Diptera: Chironomidae) of India and Bhutan. – Entomologica Scandinavica Supplementa 29: 23-33.

Chaudhuri, P. K., D. K. Guha & S. K. Das Gupta, 1981. Taxonomic studies of Chironominae (Diptera: Chironomidae) from India. The genus *Polypedilum* Kieffer. – Tijdschrift voor Entomologie 124: 111-147.

Chaudhuri, P. K., D. K. Guha & M. Ghosh, 1984. Tanytarsini (Diptera: Chironomidae) from India. – Oriental Insects 18: 31-41.

Chaudhuri, P. K., S. K. Nandi & M. Ghosh, 1983. Postembryonic stages of *Tanyptus bilobatus* (Kieffer) comb. n. (Diptera, Chironomidae) with a note on its biology. – Archiv für Hydrobiologie 97: 122-133.

Contreras-Lichtenberg, R., 1986. Revision der in der Westpaläarktis Verbreiteten Arten des Genus *Dicrotendipes* Kieffer, 1913 (Diptera, Nematocera, Chironomidae). – Annalen des Naturhistorischen Museums, Wien 88/89: 663-726.

Corbet, P. S., 1964. Temporal patterns of emergence in aquatic insects. – Canadian Entomologist 96: 264-279.

Corbet, P. S., 1966. Diel periodicities of emergence and oviposition in riverine Trichoptera. – Canadian Entomologist 98: 1025-1034.

Conquillet, D. W., 1901. New Diptera in the U.S. National Museum. – Proceedings of the United States National Museum 23: 593-618.

Cranston, P. S. & P. D. Armitage, 1990. The Canary Islands Chironomidae described by T. Becker and by E. Santos Abreu. – Deutsche Entomologische Zeitschrift (in press).

Danks, H. V., 1971. Life history and biology of *Einfeldia synchroa* (Diptera: Chironomidae). – Canadian Entomologist 103: 589-604.

Danks, H. V. & D. R. Oliver, 1972. Diel periodicities of emergence of some high arctic Chironomidae (Diptera). – Canadian Entomologist 104: 903-916.

Darby, R. E., 1962. Midges associated with California rice fields, with special reference to their ecology (Diptera, Chironomidae). – Hilgardia 32: 1-206.

Das Gupta, S. K. & W. W. Wirth, 1968. Revision of Oriental species of *Stilobezzia* Kieffer (Diptera, Ceratopogonidae). – Bulletin of the United States National Museum 283: 1-164.

Downes, J. A., 1969. The swarming and mating flight of Diptera. – Annual Review of Entomology 14: 271-298.

Edwards, F. W., 1928. Nematocera. – In: Insects of Samoa. – Bulletin of the British Museum (Natural History) 6: 23-102.

Edwards, F. W., 1929. British non-biting midges (Diptera, Chironomidae). – Transaction of the Royal Entomological Society of London 77: 279-430.

Epler, J. H., 1988. Biosystematics of the genus *Dicrotendipes* Kieffer, 1913 (Diptera: Chironomidae: Chironominae) of the world. – Memoirs of the American Entomological Society 36: 1-214.

Forsyth, D. J., 1971. Some New Zealand Chironomidae (Diptera). – Journal of the Royal Society of New Zealand 1 (2): 113-144.

Freeman, P., 1954. Chironomidae (Diptera) from Western Cape Province III. – Proceedings of the Royal Entomological Society of London 23: 17-25.

Freeman, P., 1955a. Diptera (Nematocera) Chironomidae. – South African Animal Life 2: 261-281.

Freeman, P., 1955b. Chironomidae (Diptera, Nematocera). – Exploration du Parc National Albert, Mission G. F. de Witte 83: 3-41.

Freeman, P., 1955c. A study of the Chironomidae of Africa South of Sahara. – Bulletin of the British Museum (Natural History), Entomology 4: 1-67.

Freeman, P., 1956. Some Chironomidae (Diptera) from French West-Africa. – Bulletin de l'Institut française d'Afrique Noire 18: 93-96.

Freeman, P., 1957. A study of Chironomidae (Diptera) of Africa South of the Sahara. III. – Bulletin of the British Museum (Natural History), Entomology 5: 323-426.

Freeman, P., 1958. A study of Chironomidae (Diptera) of Africa south of the Sahara IV. – Bulletin of the British Museum (Natural History), Entomology 6: 263-363.

Freeman, P., 1961a. The Chironomidae (Diptera) of Australia. – Australian Journal of Zoology 9: 611-737.

Freeman, P., 1961b. A collection of Chironomidae and Culicidae, subfamily Dixinae (Diptera, Nematocera) from Madagascar. – Memoirs of the Institute of Science, Madagascar, Series E 12: 238-255.

Freeman, P. & P. S. Cranston, 1980. Catalogue of the Diptera of the Afrotropical region II. Family Chironomidae. – Trustees of the British Museum (Natural History) 175-202.

Ghosh, M. & P. K. Chaudhuri, 1983. Developmental stages and their morphoanatomical characteristics of *Cladotanytarus gloveri* (Diptera: Chironomidae) with a note on its biology. – Proceedings of the 70th Indian Science Congress, Part III: 126.

Gillespie, J. M., 1974. A biosystematic study of Idaho Chironomini (Diptera: Chironomidae). – Ph. D. Dissertation, University of Idaho, 389 pp.

Glover, B., 1973. The Tanytarsini (Diptera: Chironomidae) of Australia. – Australian Journal of Zoology, Supplementary series 23: 403-478.

Goetghebuer, M., 1921. Chironomides de Belgique et spécialement de la zone des Flandres. – Mémoires du Musée Royal d'Histoire naturelle de Belgique 7 (4): 1-209.

Goetghebuer, M., 1928. Diptères (Nématocères), Chironomidae. III. Chironomariae. – Faune de France 5: 1-174.

Goetghebuer, M., 1930. Chironomides Palearctiques (Diptères) conservés au Musée d'Histoire Naturelle de Vienne. – Annales des Naturhistorischen Museums. Wien 46: 91-115.

Goetghebuer, M., 1934. Ceratopogonides et Chironomides du Congo Belge (deuxième note). – Revue de Zoologie et de Botanique Africaines 25: 191-205.

Goetghebuer, M., 1936a. Chironomides du Congo Belge. – Revue de Zoologie et de Botanique Africaines 28: 453-492.

Goetghebuer, M., 1936b. Tendipedidae (Chironomidae) a) Subfamilie Pelopiinae (Tanyopodinae). A. Die Imagines. – Die Fliegen der Palaearktischen Region 13b: 1-50.

Goetghebuer, M., 1937-1954. Tendipedidae (Chironomidae). b) Subfamilie Tendipedinae (Chironominae). A. Die Imagines. – Die Fliegen der Palaearktischen Region 13c: 1-138.

Grodhaus, G., 1963. Chironomid midges as a nuisance 11. The nature of the nuisance and remarks on its control. – California Vector views 10: 27-37.

Guha, D. K. & P. K. Chaudhuri, 1979. A new species of genus *Cryptochironomus* Kieffer (Chironomidae, Diptera) from India. – Bulletin of the Zoological Survey of India 2 (1): 95-97.

Guha, D. K. & P. K. Chaudhuri, 1981. Record of three genera of Chironominae (Chironomidae: Diptera) from India. – Bulletin of the Zoological Survey of India 3 (3): 159-165.

Guha, D. K. & P. K. Chaudhuri, 1983. Record of *Polypedilum* Kieffer (Diptera: Chironomidae) in Bhutan and India with a new species from India. – Journal of the Bombay Natural History Society 79 (3): 635-638.

Guha, D. K. & P. K. Chaudhuri, 1985. *Pentapedilum robusticeps* (Diptera: Chironomidae) – A new species from India. – Bulletin of the Zoological Survey of India 7 (2-3): 195-197.

Guha, D. K., P. K. Chaudhuri & S. K. Nandi, 1982. Taxonomic studies of Chironominae (Chironomidae: Diptera) from West Bengal: Genus *Dicotendipes* Kieffer. – Proceedings of the Zoological Society, Calcutta 33: 29-38.

Guha, D. K., S. K. Das, P. K. Chaudhuri & D. K. Choudhuri, 1985. Chironomid midges of the Andaman islands (Diptera: Chironomidae) – Proceedings of the Natural Academy of Science, India 55 (B): 22-38.

Hamilton, A. L., 1965. An analysis of a freshwater benthic community with special reference to the Chironomidae. – Ph. D. Thesis, Department of Zoology, University of British Columbia I: 93 pp II: 216 pp.

Hashimoto, H., 1977. The *Chironomus* of Japan. – Iden 31 (4): 78-84.

Hashimoto, H., 1983. *Pentapedilum* (Diptera, Chironomidae) from Japan, with description of a new species. – Kontyû, Tokyo 51: 17-24.

Hashimoto, H., T. Wongsiri, N. Wongsiri, C. Tirawat, A. Lewvanich & K. Yasumatsu, 1981. Chironominae from rice fields of Thailand with descriptions of 7 new species. – Technical Bulletin. Taxonomy Branch, Entomology & Zoology Division, Department of Agriculture, Bangkok, 7: 1-47.

Hein, J. & J. C. Schmulbach, 1972. Biology of the pupal and imago stages of *Chironomus pallidivittatus* (Chironomidae: Diptera). – Proceedings of the South Dakota Academy of Sciences 51: 80-88.

Hilsenhoff, W. L., 1966. The biology of *Chironomus plumosus* (Diptera: Chironomidae) in Lake Winnibago, Wisconsin. – Annals of the Entomological Society of America 59: 465-473.

Ishihara, T., 1972. An introduction to the study of agricultural insects of Japan. – Yokendo, Tokyo, 310 pp.

Johannsen, O. A., 1905. Aquatic nematocerous Diptera. – In: Needham, I. G., Morton, K. I. Johannsen, O. A. (eds): May flies and midges of New York. – Bulletin of the New York State Museum 86: 7-327.

Johannsen, O. A., 1908. New North American Chironomidae. In: E. P. Felt (ed.), 23rd report of the State Entomologist on injurious and other insects of the State New York, 1907. – Bulletin of the New York State Museum, 124: 264-285.

Johannsen, O. A., 1932. Chironominae of the Malayan Subregion of the Dutch East Indies. – Archiv für Hydrobiologie, Supplement 11: 503-552.

Johannsen, O. A., 1937. Aquatic Diptera. IV. Chironomidae: Subfamily Chironominae. – Memoirs of the Cornell University agricultural Experimental Station 210: 3-56.

Johannsen, O. A., 1946. Some new species of nematocerous Diptera from Guam. – Bulletin of the Bernice P. Bishop Museum 189: 187-193.

Jónasson, P. M., 1965. Factors determining population size of *Chironomus anthracinus* in Lake Esrom. – Mitteilungen der Internationalen Vereinigung für theoretische und angewandte Limnologie 13: 139-162.

Jónasson, P. M. & J. Kristiansen, 1967. Primary and secondary production in lake Esrom. Growth of *Chironomus anthracinus* in relation to seasonal cycle of phytoplankton and dissolved oxygen. – Internationale Revue der gesamten Hydrobiologie und Hydrographie 52: 163-217.

Jones, E. L., 1968. *Chironomus tepperi* Skuse (Diptera: chironomidae) as a pest of rice in New South Wales. – Australian Journal of Science 31 (2): 89.

Kieffer, J. J., 1906. Diptera Fam. Chironomidae. – Genera Insectorum 42: 1-78.

Kieffer, J. J., 1910. Étude sur les chironomides des îles Orientales, avec description de quelques nouvelles espèces d'Egypte. – Memoirs of the Indian Museum 2: 181-242.

Kieffer, J. J., 1911. Description de nouveaux Chironomides de l'Indian Museum de Calcutta. – Records of the Indian Museum 6: 113-177.

Kieffer, J. J., 1912. Tendipedidae (Dipt.) – In: Formosa – Ausbeute. – Supplement entomologica 1: 27-43.

Kieffer, J. J., 1913a. Chironomidae et Cecidomyidae. – Voyage de Ch. Alluaud et R. Jeannel en Afrique Orientale (1911-1912). Résultats Scientifiques, Insectes Diptères: 1-43, Paris 1913.

Kieffer, J. J., 1913b. Nouvelle études sur les Chironomides de l'Indian Museum de Calcutta. – Records of the Indian Museum 9: 119-197.

Kieffer, J. J., 1914. South African Chironomidae (Diptera). – Annals of the South African Museum 10: 259-270.

Kieffer, J. J., 1916. Tendipedidae (Chironomidae) de Formose conservés au Musée National Hongrois de Budapest et déterminés par J. J. Kieffer. – Annales Historico-Naturales Musei Nationalis Hungarici 14: 81-121.

Kieffer, J. J., 1917. Chironomides d'Australie conservés au Musée National Hongrois de Budapest. – Annales Historico-Naturales Musei Nationalis Hungarici 15: 175-228.

Kieffer, J. J., 1918. Beschreibung neuer, auf Lazaretschiffen des östlichen Kriegsschauplatzes und bei Ignalino in Litauen von Dr. W. Horn gesammelter Chironomiden, mit Übersichts-tabellen einiger Gruppen von paläarktischen Arten (Dipt.). – Entomologische Mitteilungen 7: 35-53.

Kieffer, J. J., 1921a. Chironomides des Philippines et de Formose. – Philippine Journal of Science 18: 557-593.

Kieffer, J. J., 1921b. Nouveaux représentations de genre *Polypedilum* (Chironomides). – Annales de la Société Scientifique de Bruxelles 4: 97-101.

Kieffer, J. J., 1922. Chironomides de l'Afrique Équatoriale (11e partie). – Annales de la Société entomologique de France 91: 1-72.

Kieffer, J. J., 1923. Chironomides de l'Afrique Équatoriale, (11e partie). – Annales de la Société entomologique de France 92: 149-204.

Kieffer, J. J., 1924a. Six nouveaux chironomides d'Afrique. – Annales de la Société Scientifique de Bruxelles 43: 255-261.

Kieffer, J. J., 1924b. Chironomides non piqueurs de Java. – Annales de la Société Scientifique de Bruxelles 43: 262-270.

Kieffer, J. J., 1925. Chironomides d'Egypte (Dipt.). – Bulletin, Société Entomologique d'Egypte 8: 244-313.

Kruseman, G., 1933. Tendipedidae Neerlandicae. I: Genus *Tendipes* cum generibus finitimus. – Tijdschrift voor Entomologie 76: 119-216.

Kruseman, G., 1949. Note on Tendipedidae of the Suez Canal. – Bijdragen tot de Dierkunde 28: 249-254.

Kugler, J., 1971. The developmental stages of *Leptochironomus stilifer* (Diptera: Chironomidae) and the characters of the genus *Leptochironomus*. – Canadian Entomologist 103: 341-346.

Linderberg, B., 1971. Parthenogenetic strains and unbalanced sex ratios in Tanytarsini (Diptera, Chironomidae). – Annales Zoologici Fennici 8: 310-317.

Linnaeus, C., 1767. Systema Naturae, 12th Edition.

Malloch, J. R., 1915. The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. – Bulletin of the Illinois State Laboratory of Natural History 10: 274-543.

Martin, J., 1966. Female heterogamety in *Polydipetalum nubifer* (Diptera: Nematocera). – American Naturalist 100: 157-159.

Martin, J. & D. L. Porter, 1977. Laboratory biology of the rice midge, *Chironomus tepperi* Skuse (Diptera: Nematocera): mating, behaviour, productivity and attempts at hybridization. – Journal of the Australian Entomological Society 16: 411-416.

Mason, P. G., 1985. Four new species of the *Cryptochironomus fulvus* (Johannsen) species complex (Diptera: Chironomidae). – Entomologica Scandinavica 16: 399-413.

McCauley, V. J. E., 1974. Instar differentiation in larval Chironomidae (Diptera). – Canadian Entomologist 106: 179-200.

McLachlan, A. J., 1969. Notes on some larval and pupal chironomids (Diptera) from Lake Kariba, Rhodesia. – Journal of Natural History, London 3: 261-293.

Miall, L. C. & A. R. Hammond, 1900. The structure and life history of the Harlequin fly (*Chironomus*). – 106 pp., Clarendon Press, Oxford.

Mitchell, E. G., 1908. Description of nine new species of gnats. – Journal of the New York Entomological Society 16: 7-14.

Moller Pillot, H. K. M., 1984. De larven der Nederlandse Chironomidae (Diptera). Inleiding, Tanyopodinae en Chironomini. – Nederlandse Faunistische Mededelingen, Leiden 1A: 1-278.

Morgan, N. C. & A. B. Waddell, 1961. Diurnal variation in the emergence of some aquatic insects. – Transactions of the Royal Entomological Society, London 113: 123-137.

Mundie, J. H., 1956. The biology of flies associated with water supply. – Session meeting of the Institution of Public Health Engineers 55: 178-193.

Oliver, D. R., 1968. Adaptations to arctic Chironomidae. – Annales Zoologici Fennici 5: 11-118.

Oliver, D. R., 1971. Life history of Chironomidae. – Annual Review of Entomology 16: 211-230.

Pagast, F., 1931. Chironomiden aus der Bodenfauna des Usma-Sees in Kurland. – Folia Zoologica et Hydrobiologica 3: 199-248.

Palmén, E., 1962. Studies on the ecology and phenology of chironomids (Dipt.) of the Northern Baltic. I. *Allochironomus crassiforceps* K. – Suomen Hyöteistieteenliinen Aikakauskirja 28: 137-168.

Pinder, L. C. V., 1978. A key to the adult males of British Chironomidae (Diptera), the non-biting midges. – Scientific Publications, Freshwater Biological Association 37 (2 vols): 1-169, figs. 1-189.

Pinder, L. C. V. & F. Reiss, 1983. The larvae of Chironominae (Diptera: Chironomidae) of the Holarctic region. Keys and diagnoses. – Entomologica Scandinavica, Supplement 19: 293-435.

Ping, C., 1917. Observations on *Chironomus decorus* Johannsen. – Canadian Entomologist 49: 418-426.

Porter, D. L. & J. Martin, 1977. The cytology of *Polydipetalum nubifer* (Diptera: Chironomidae). – Caryologia 30: 41-62.

Ree, H. I., 1981. Studies on Korean Chironomidae (Diptera). 2. Description of a new genus and a new species of Chironomidae. – Korean Journal of Zoology 24: 217-220.

Ree, H. I. & H. S. Kim, 1981. Studies on Chironomidae (Diptera) in Korea I. Taxonomical study on adults of Chironomidae. – Proceedings of the College of Natural Sciences, Seoul National University, 6 (1): 123-226.

Reiss, F., 1977. Verbreitungsmuster bei paläarktischen Chironomidenarten (Diptera, Chironomidae). – Spixiana 1: 85-97.

Reiss, F., 1978. Sich abzeichnende Verbreitungsmuster in der paläarktischen-paläotropischen Chironomidenfauna (Dipt.). – Mitteilungen der Deutsche Gesellschaft für allgemeine und angewandte Entomologie 1: 72-76.

Reiss, F., 1986. Ein Beitrag zur Chironomidenfauna Syriens (Diptera, Chironomidae). – Entomofauna 7: 153-168.

Risbec, J., 1952. Les insectes nuisibles au riz dans le midi de la France. Les Riziculteurs de France. – Bulletin 18 Etude technique 51: 14-19.

Sadler, W. O., 1935. Biology of the midge *Chironomus tentans* Fabricius, and methods for its propagation. – Memoirs of the University Agricultural Experimental Station 173: 1-25.

Sæther, O. A., 1968. Chironomids of the Finse area, Norway, with special reference to their distribution in a glacier brook. – Archiv für Hydrobiologie 64: 426-483.

Sæther, O. A., 1977. Taxonomic studies in Chironomidae; *Nanocladius*, *Pseudochironomus* and the *Harnischia* complex. – Bulletin, Fisheries Research Board of Canada 196: 1-143.

Sæther, O. A., 1980. Glossary of chironomid morphology terminology (Diptera: Chironomidae). – Entomologica Scandinavica Supplement 14: 1-51.

Sasa, M., 1978. A comparative study of adults and immature stages of nine Japanese species of the genus *Chironomus* (Diptera: Chironomidae). – Research report of the National Institute of Environmental Studies, Japan, 3: 1-63.

Sasa, M., 1979. A morphological study of adults and immature stages of 20 Japanese species of the family Chironomidae (Diptera). – Research report of the National Institute of Environmental Studies, Japan 7: 1-148.

Sasa, M., 1983. Studies on chironomid midges of the Tama River. Part 5. An observation on the distribution of Chironominae along the main stream in June, with description of 15 new species. – Research report of the National Institute of Environmental Studies 43: 1-67.

Sasa, M., 1985. Studies on Chironomid Midges of some lakes in Japan. Part II. Studies on the Chironomid collected from lakes in Southern Kyushu (Diptera, Chironomidae). – Research report of the National Institute of Environmental Studies, Japan 83: 25-99.

Sasa, M. & H. Hasegawa, 1983. Chironomid midges of the tribe Chironomini collected from sewage ditches, eutrophicated ponds, and some clean streams in the Ryukyu Islands, Southern Japan. – Japan Journal of Sanitary Zoology 34: 305-341.

Sasa, M. & M. Kikuchi, 1986. Notes on the chironomid midges of the subfamilies Chironominae and Orthocladiinae collected by light traps in a rice paddy area in Tokushima (Diptera, Chironomidae). – Japan Journal of Sanitary Zoology 31: 93-102.

Sasa, M. & J. E. Sublette, 1980. Synonymy, distribution and morphological notes on *Polypedilum* (S. Str.) *nubifer* (Skuse) (Diptera: Chironomidae). – Japan Journal of Sanitary Zoology 31: 93-102.

Shilova, A. I., 1976. Chironomids of the Rybinsk reservoir (In Russian). – Izdaniya nauki, Leningrad: 1-252.

Singh, M. P. & A. D. Harrison, 1982. Diel periodicities of emergence of midges (Diptera: Chironomidae) from a wooded stream on the Niagara Escarpment, Ontario. – Aquatic Insects 4: 29-37.

Singh, S. & A. K. Kulshrestha, 1977. *Dicrotendipes rajas-thani* n. sp. from India (Diptera: Chironomidae). – Entomologica Scandinavica 8: 233-235.

Skuse, F. A. A., 1889. Diptera of Australia. Part IV. The Chironomidae. – Proceedings of the Linnean Society of New South Wales 4: 215-311.

Sublette, J. E. & M. S. Sublette, 1973. Family Chironomidae. – In: M. Delfinado & E. D. Hardy (eds.). Catalogue of the Diptera of the Oriental region, 1: 289-422, Suborder Nematocera. Hawaii.

Thienemann, A., 1954. *Chironomus* Leben, Verbreitung und Wirtschaftliche Bedeutung der Chironomiden. – Binnengewässer 20: 834 pp.

Tokunaga, M., 1936. Chironomidae from Japan (Diptera), VII. New species and a new variety of the genus *Chironomus* Meigen. – Philippine Journal of Science 60: 71-84.

Tokunaga, M., 1940a. Ceratopogonidae and Chironomidae from the Micronesian Islands. With biological notes by T. Esaki. – Philippine Journal of Science 71: 205-230.

Tokunaga, M., 1940b. Chironomidae from Japan. XII: New or little known Ceratopogonidae and Chironomidae. – Philippine Journal of Science 72: 255-311.

Tokunaga, M., 1964. Insects of Micronesia (Diptera: Chironomidae). – Bernice P. Bishop Museum 12: 458-628.

Tokunaga, M. & M. Kuroda, 1935. Unrecorded chironomid flies from Japan (Dipt.) with a description of a new species. – Transactions of the Kansas Entomological Society 6: 1-8.

Tokunaga, M. & M. Kuroda, 1936. Stenochironomid midges from Japan (Diptera), with notes on controlling methods of a leaf mining midge. – Transactions of the Kansas Entomological Society 7: 1-6.

Townes, H. K., 1945. The Nearctic species of Tendipedini (Diptera: Tendipedini (Diptera: Tendipedidae (= Chironomidae)). – American Midland Naturalist 34: 206 pp.

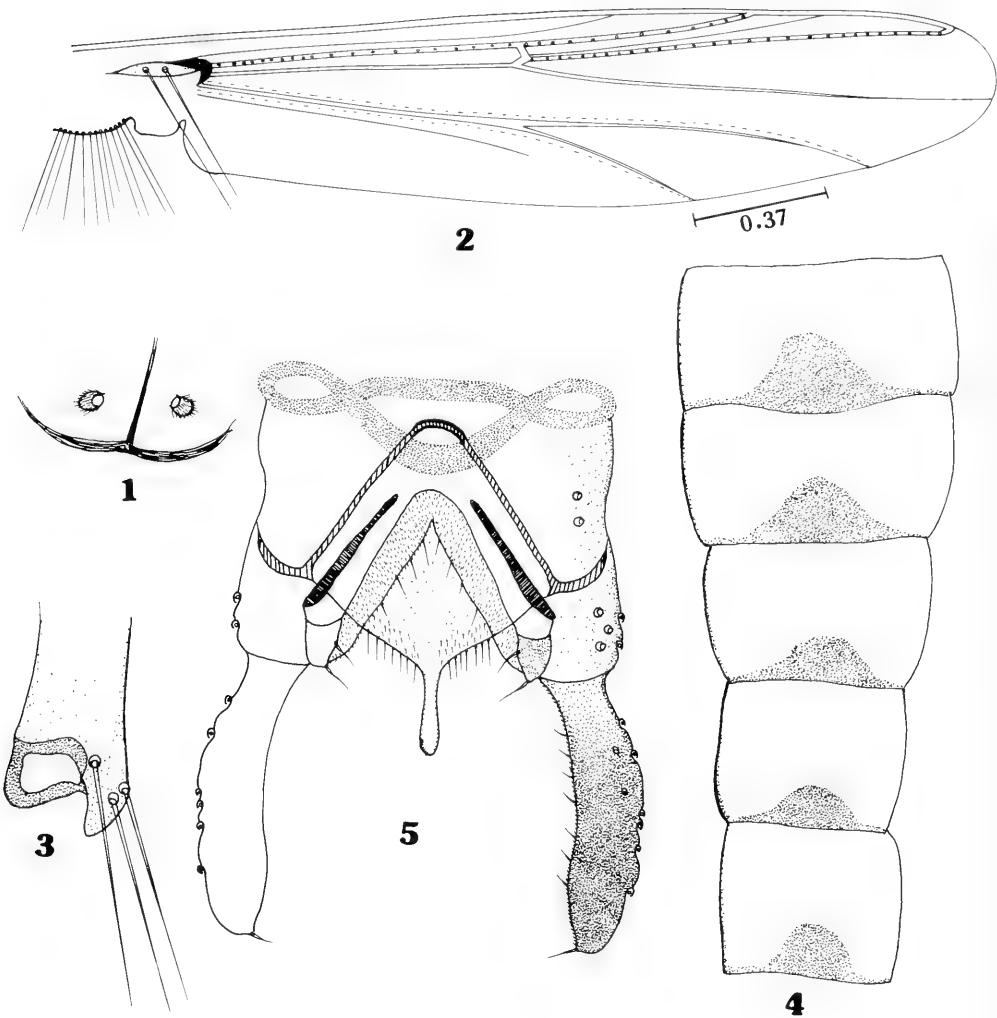
Walker, F., 1848. List of specimens of dipterous insects in the collection of the British Museum, London. 1: 1-299.

Wulp, F. M. van der, 1874. Dipterologische aantekeningen. (Dipterological remarks). – Tijdschrift voor Entomologie 17: 109-148.

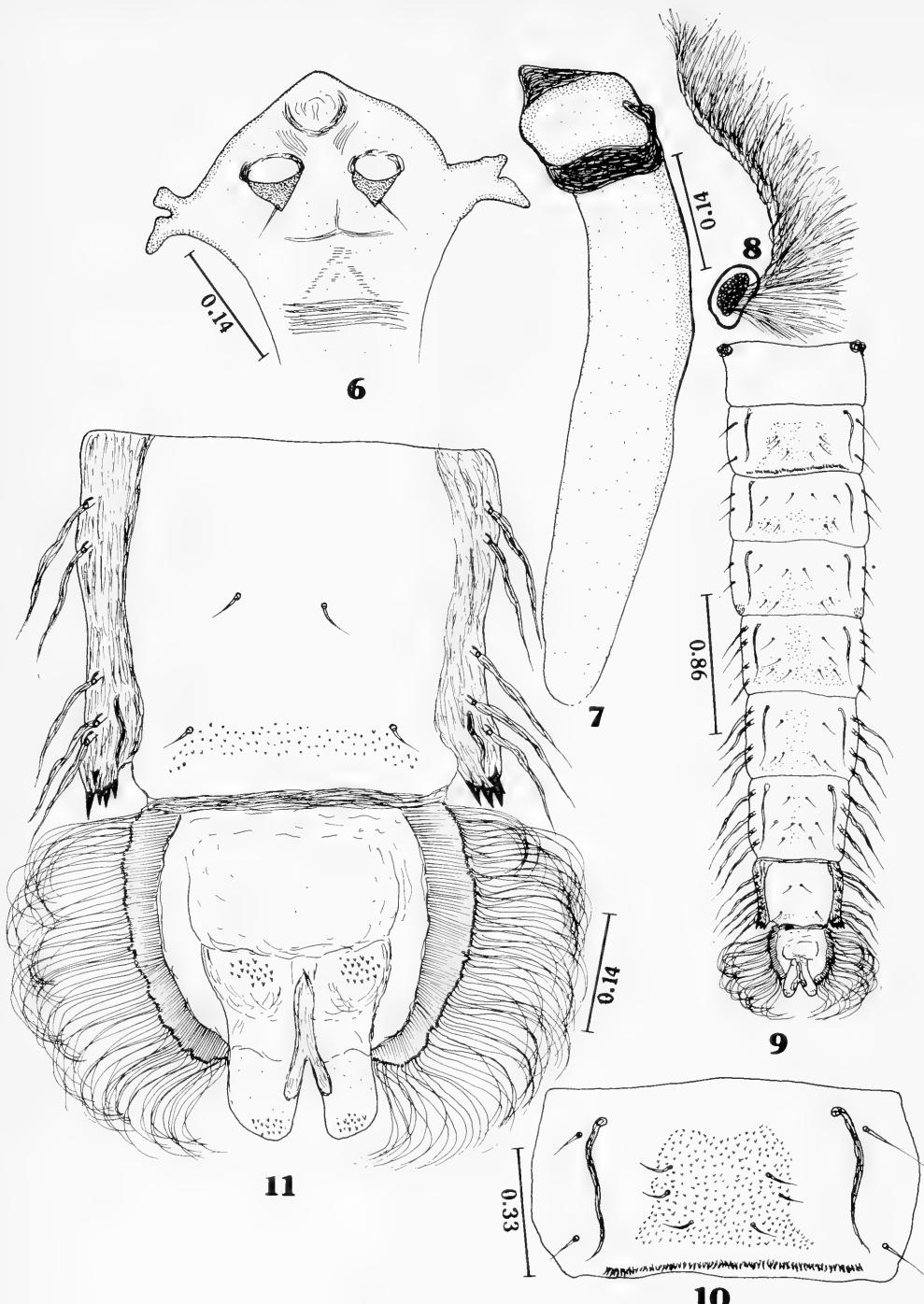
Yokogi, K. & R. Ueno, 1971. Wasabi (Japanese horseradish, *Wasabia japonica*). – Nohson – Gyoson Bunka Kyoushi, Tokyo 136 pp.

Received: 22 September 1989.

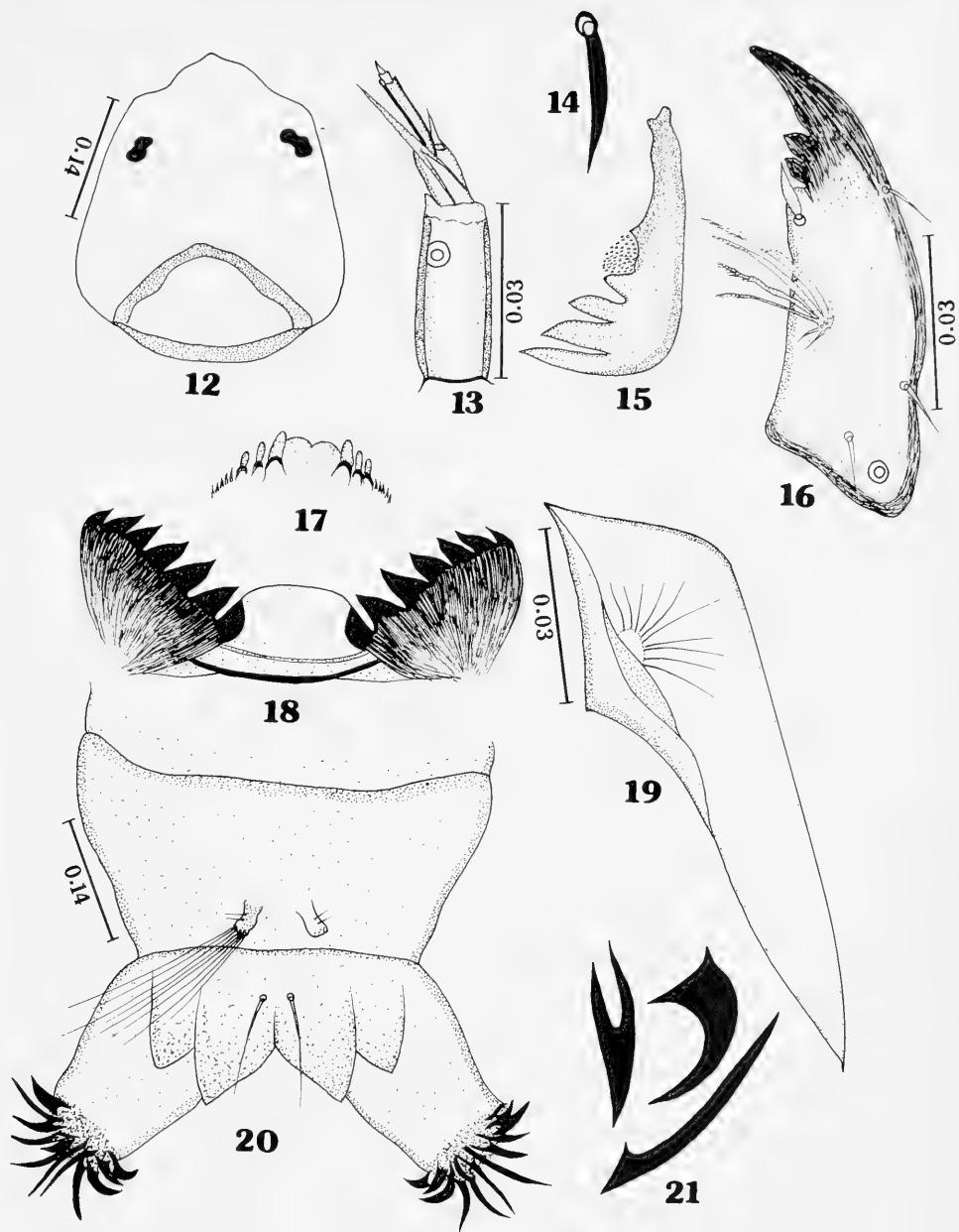
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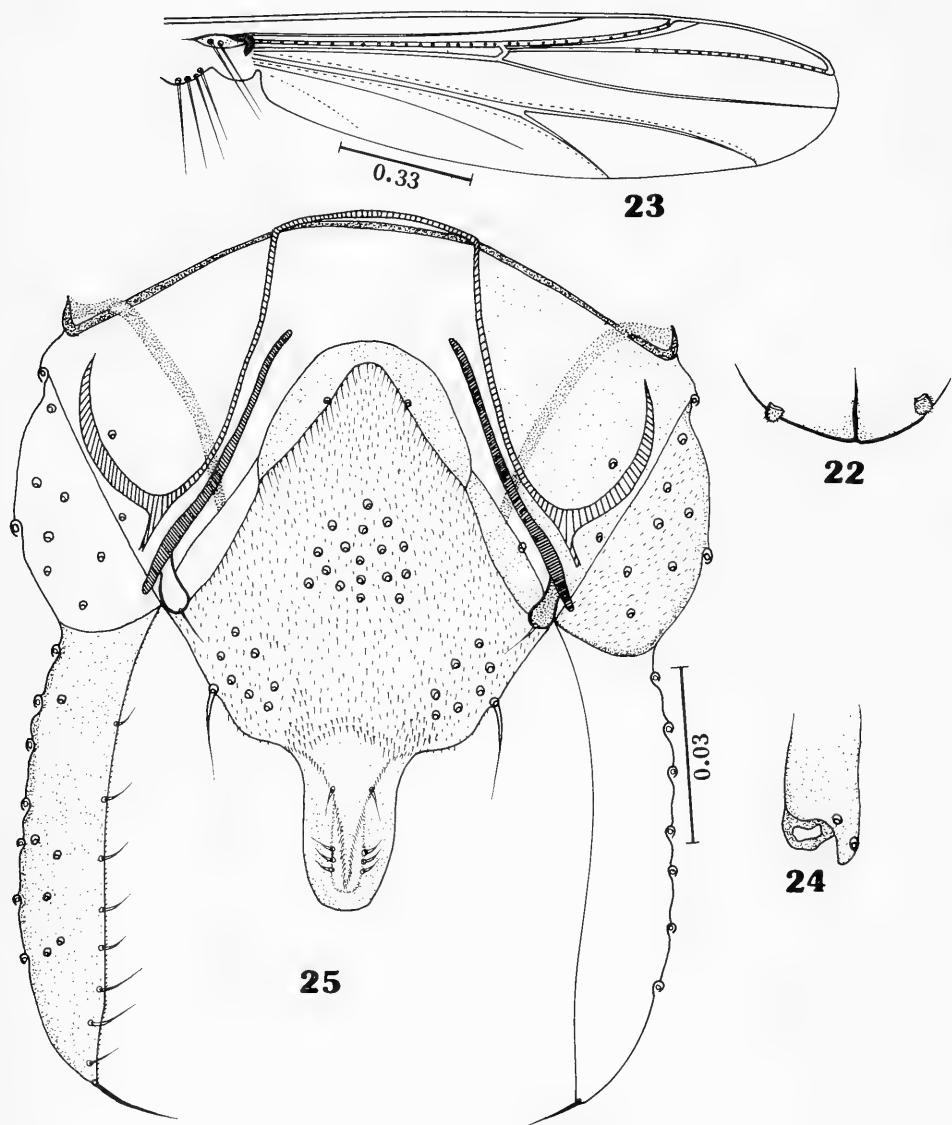
Figs. 1-5. Adults of *Cryptochironomus judicius* sp. n. 1, Frontal tubercles; 2, wing; 3, fore tibial scale; 4, tergites II-VI; 5, male hypopygium.



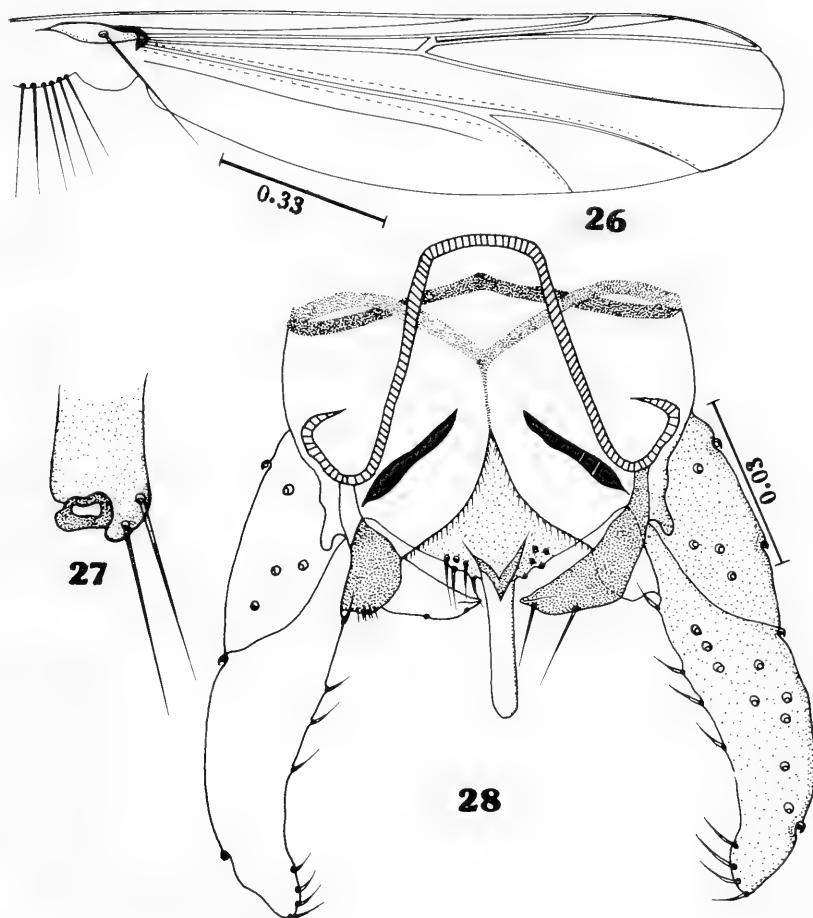
Figs. 6-11. Pupa of *Cryptochironomus judicius* sp. n. 6, Frontal apotome; 7, antennal sheath of male; 8, thoracic horn; 9, abdomen; 10, tergite II; 11, anal fin and genital sac of male.



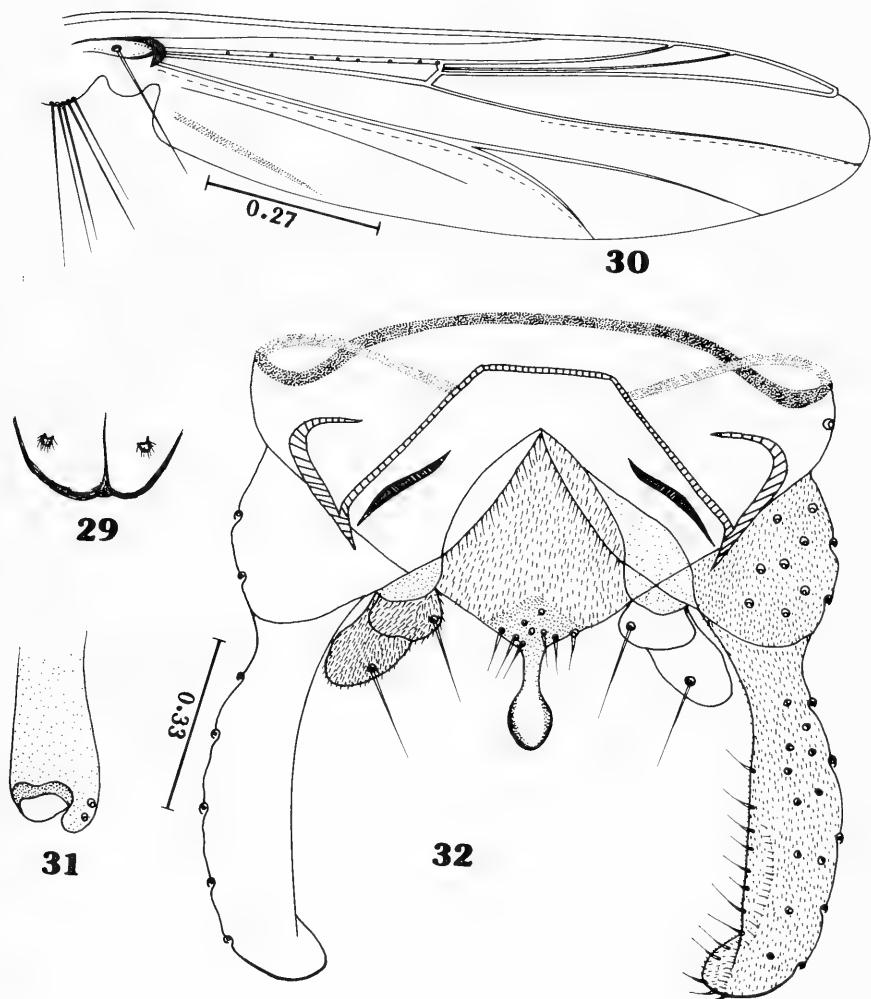
Figs. 12-21. Larva of *Cryptochironomus judicinus* sp. n. 12, Head capsule; 13, antenna; 14, S I; 15, premandible; 16, mandible; 17, prementohypopharyngeal complex; 18, mentum; 19, ventromental plate; 20, posterior abdominal segments; 21, claws of posterior parapods.



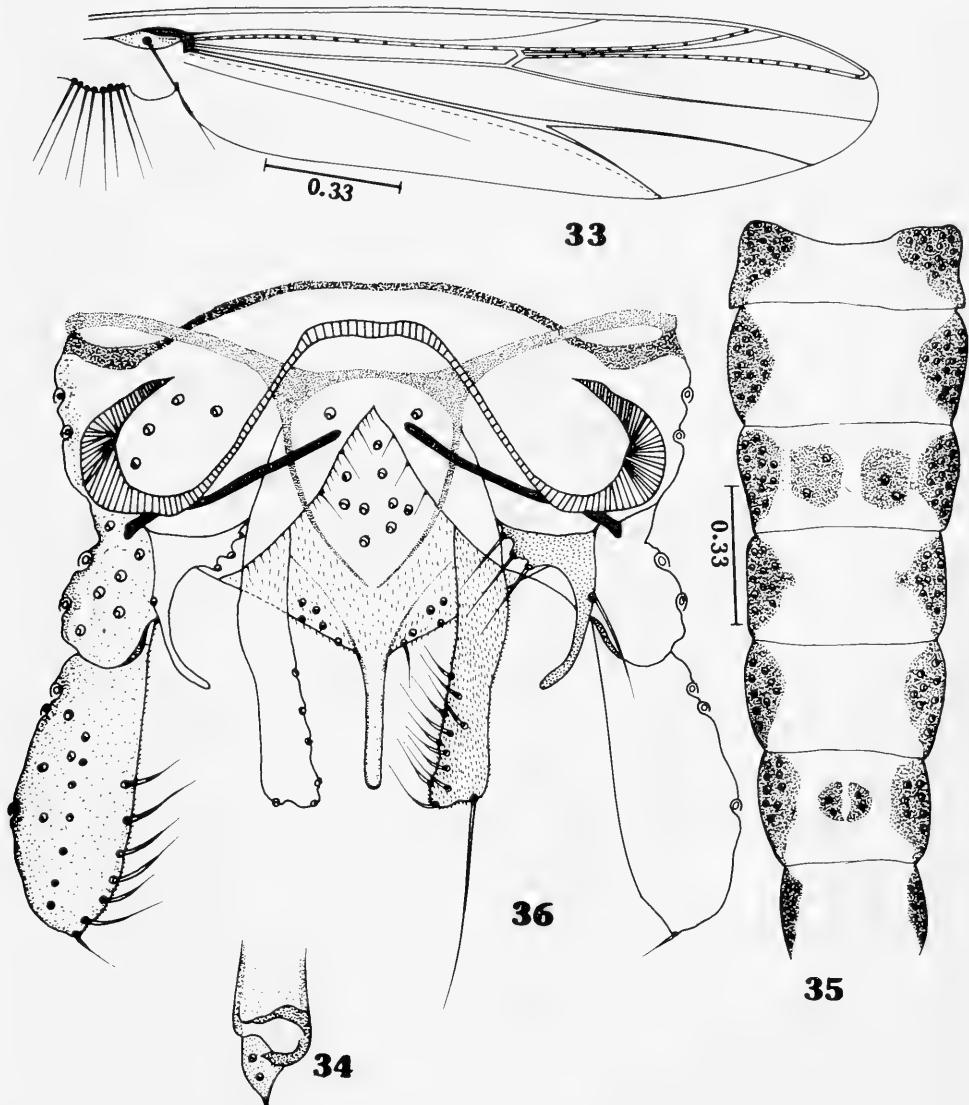
Figs. 22-25. Adult of *Harnischia tenuituberculata* sp. n. 22, Frontal tubercles; 23, wing; 24, fore tibial scale; 25, male hypopygium.



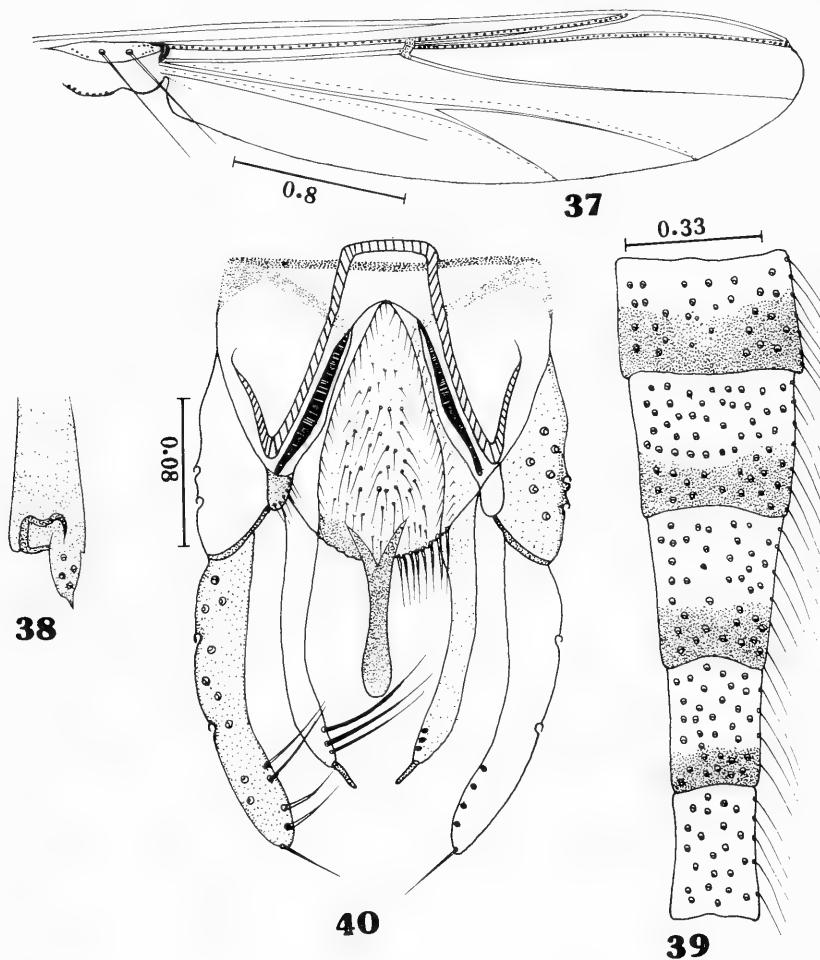
Figs. 26-28. Adult of *Paracladopelma aratra* sp. n. 26, Wing; 27, fore tibial scale; 28, male hypopygium.



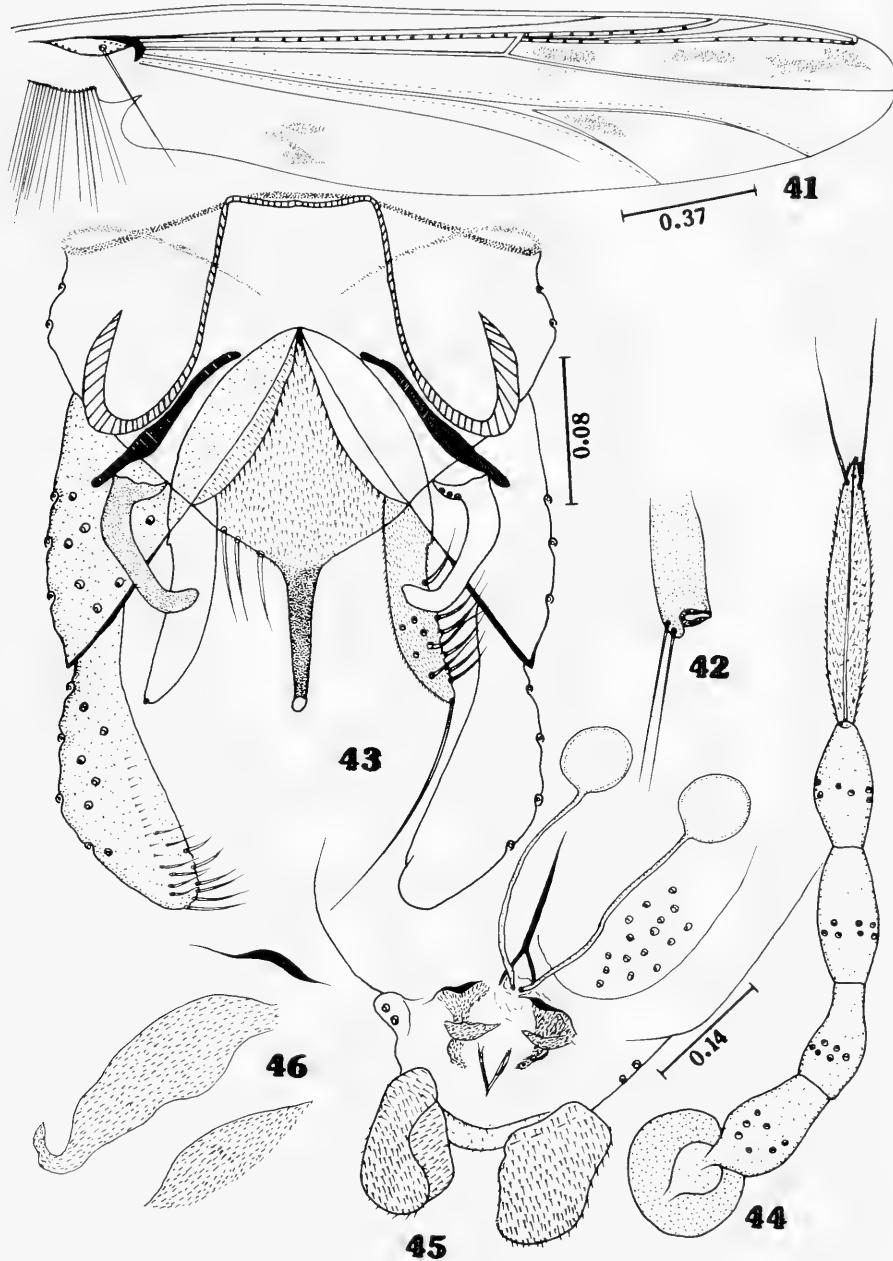
Figs. 29-32. Adult of *Paracladopelma sacculifera* sp. n. 29, Frontal tubercles; 30, wing; 31 fore tibial scale; 32, male hypopygium.



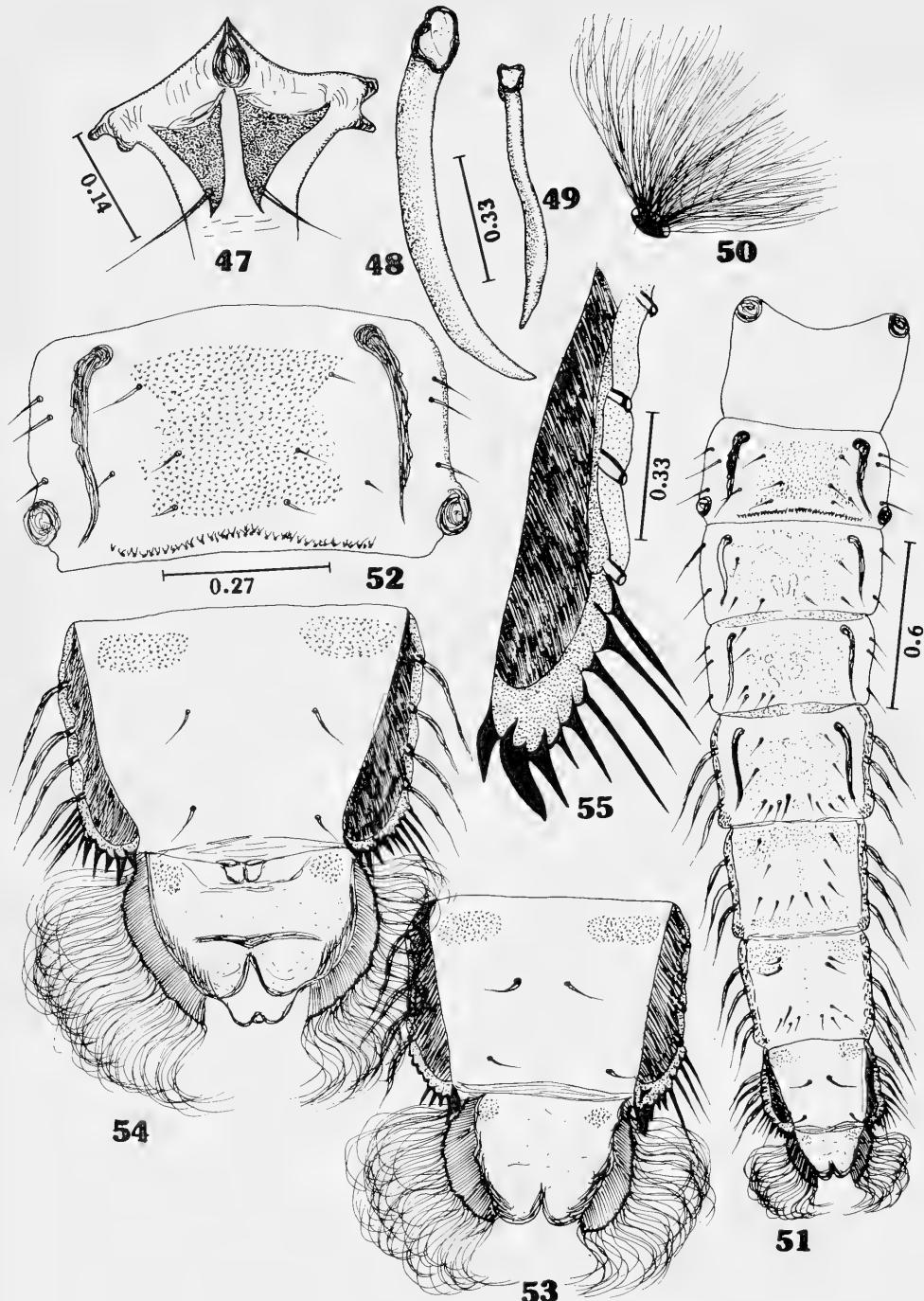
Figs. 33-36. Adult of *Polypedilum circulum* sp. n. 33, Wing; 34, fore tibial scale; 35, abdomen; 36, male hypopygium.



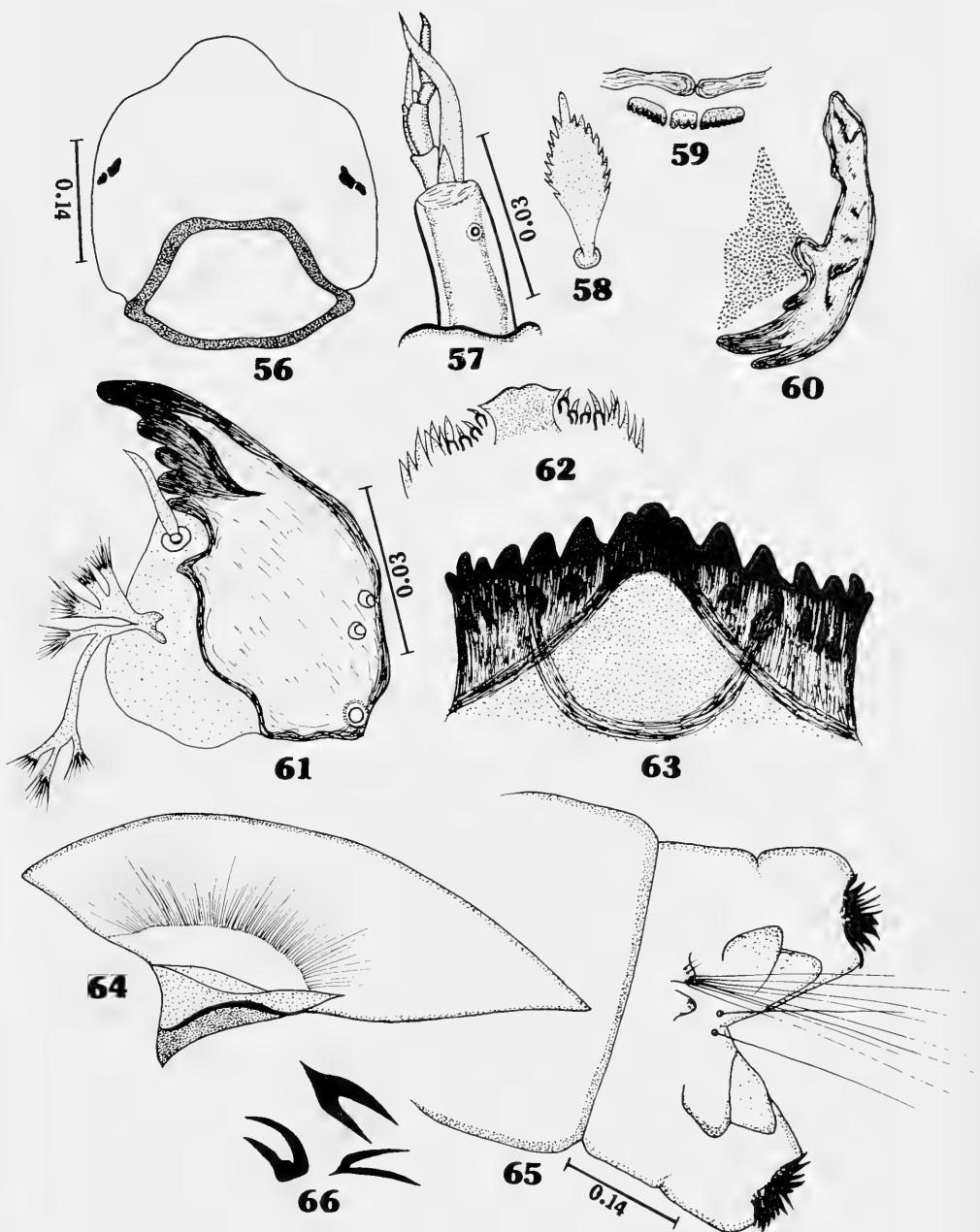
Figs. 37-40. Adult of *Stenochironomus longipalpis* (Kieffer). 37, Wing; 38, fore tibial scale; 39, abdomen; 40, male hypopygium.



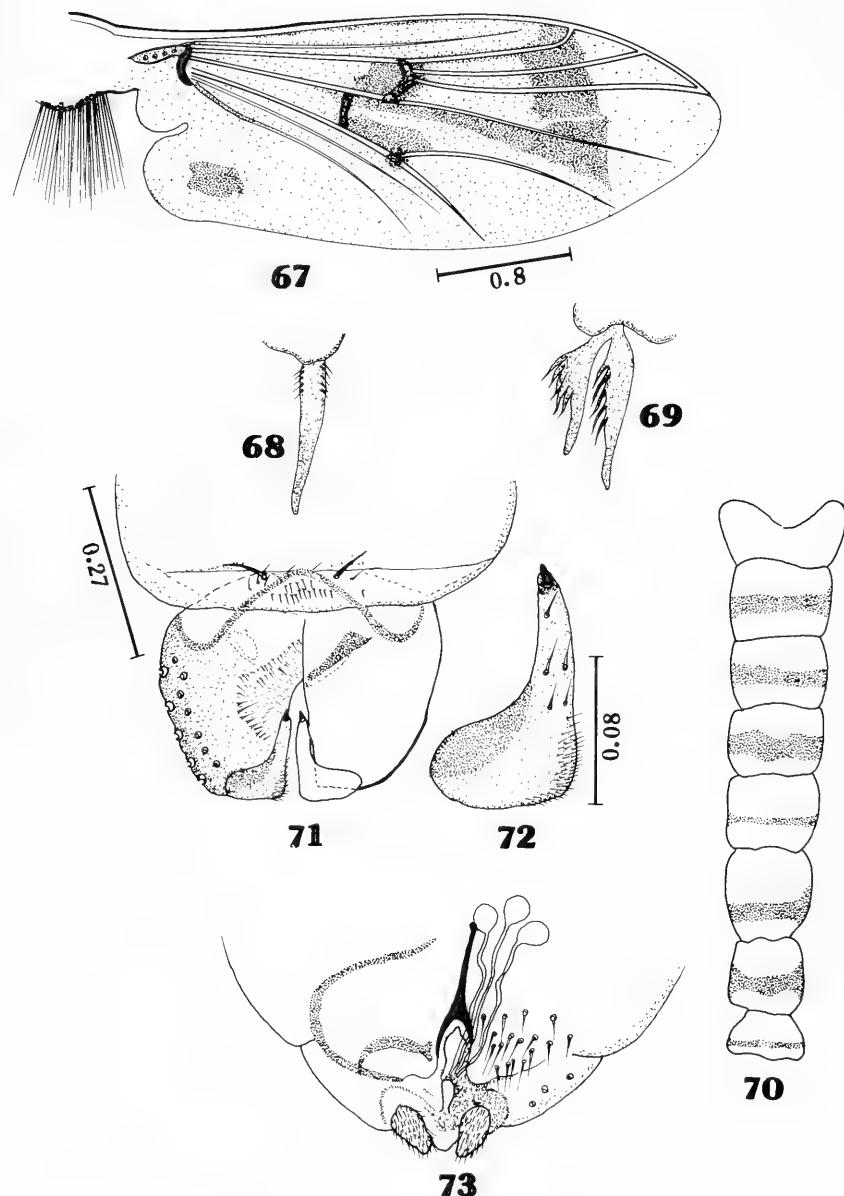
Figs. 41-46. Adult of *Stictochironomus obscurus* (Guha & Chaudhuri) comb.n. 41, Wing; 42, fore tibial scale; 43, male hypopygium; 44, female antenna; 45, female genitalia; 46, dorsomesal, ventrolateral and apodeme lobes of gonapophysis VIII.



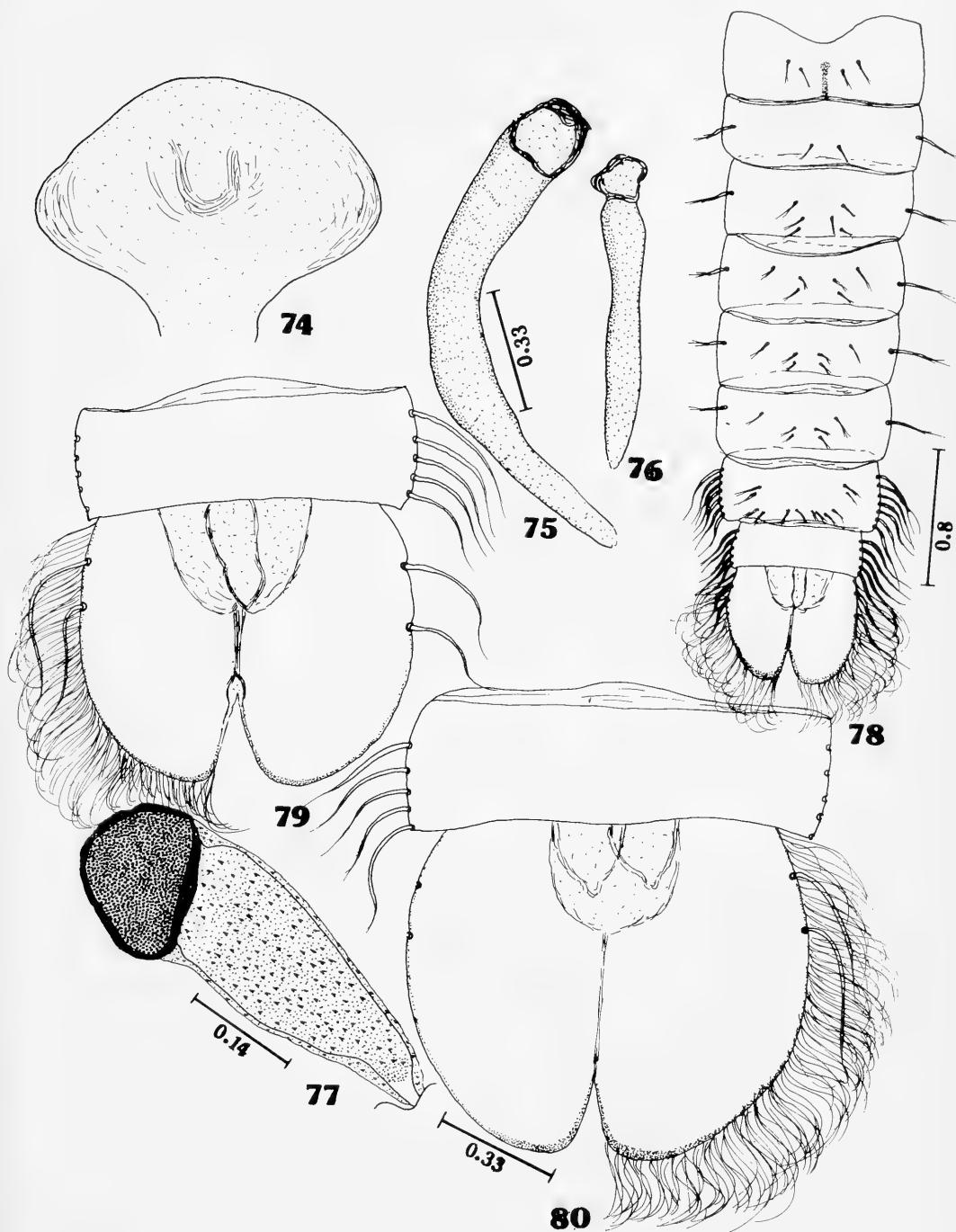
Figs. 47-55. Pupa of *Stictochironomus obscurus* (Guha & Chaudhuri) comb.n. 47, Frontal apotome; 48, antennal sheath of male; 49, antennal sheath of female; 50, thoracic horn; 51, abdomen; 52, tergite II; 53, anal fin and genital sac of male; 54, anal fin and genital sac of female; 55, caudolateral spur of segment VIII.



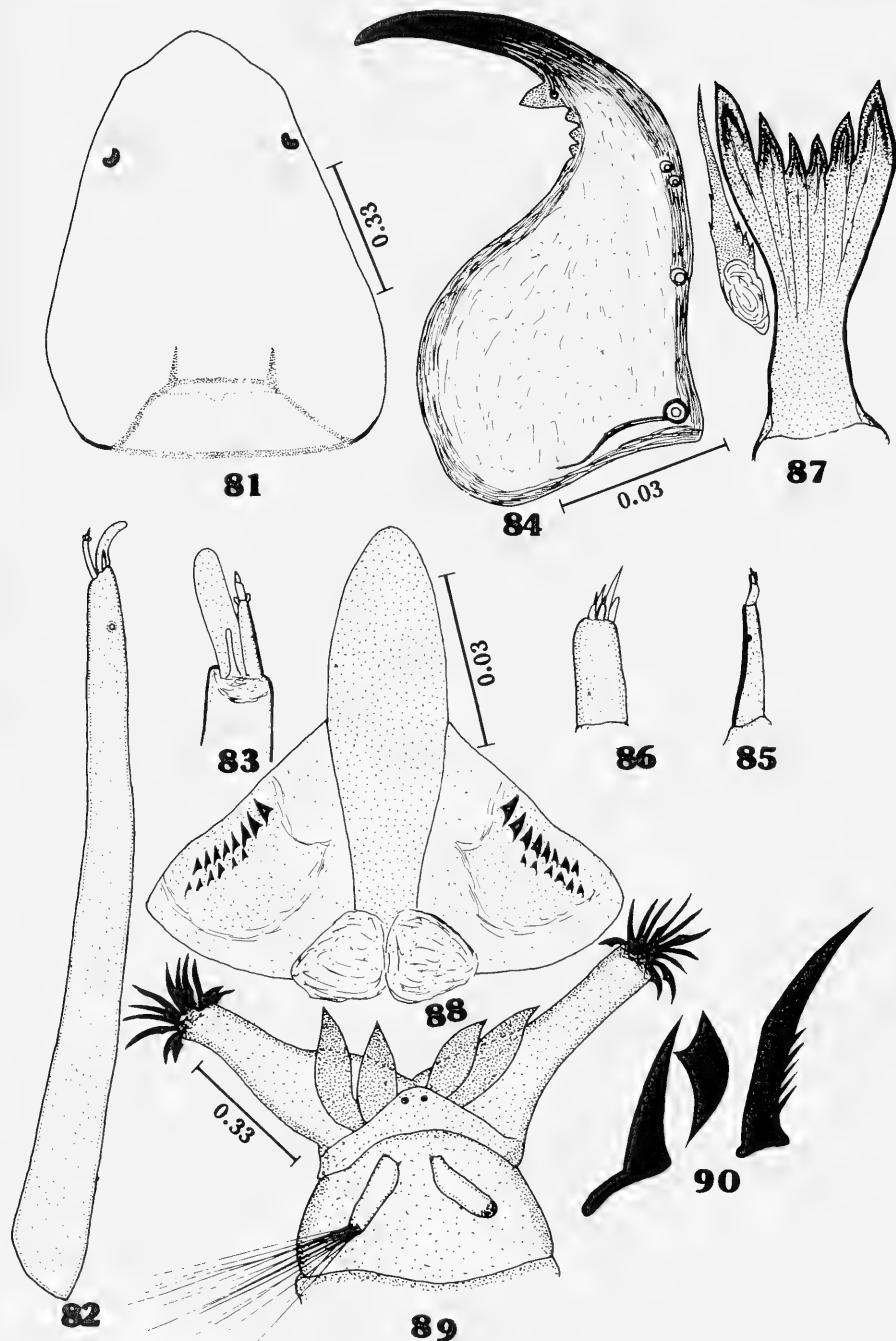
Figs. 56-66. Larva of *Stictochironomus obscurus* (Guha & Chaudhuri) comb.n. 56, Head capsule; 57, antenna; 58, S I; 59, pecten epipharyngis; 60, premandible; 61, mandible; 62, prementopharyngeal complex; 63, mentum; 64, ventromental plate; 65, posterior abdominal segments; 66, claws of posterior parapods.



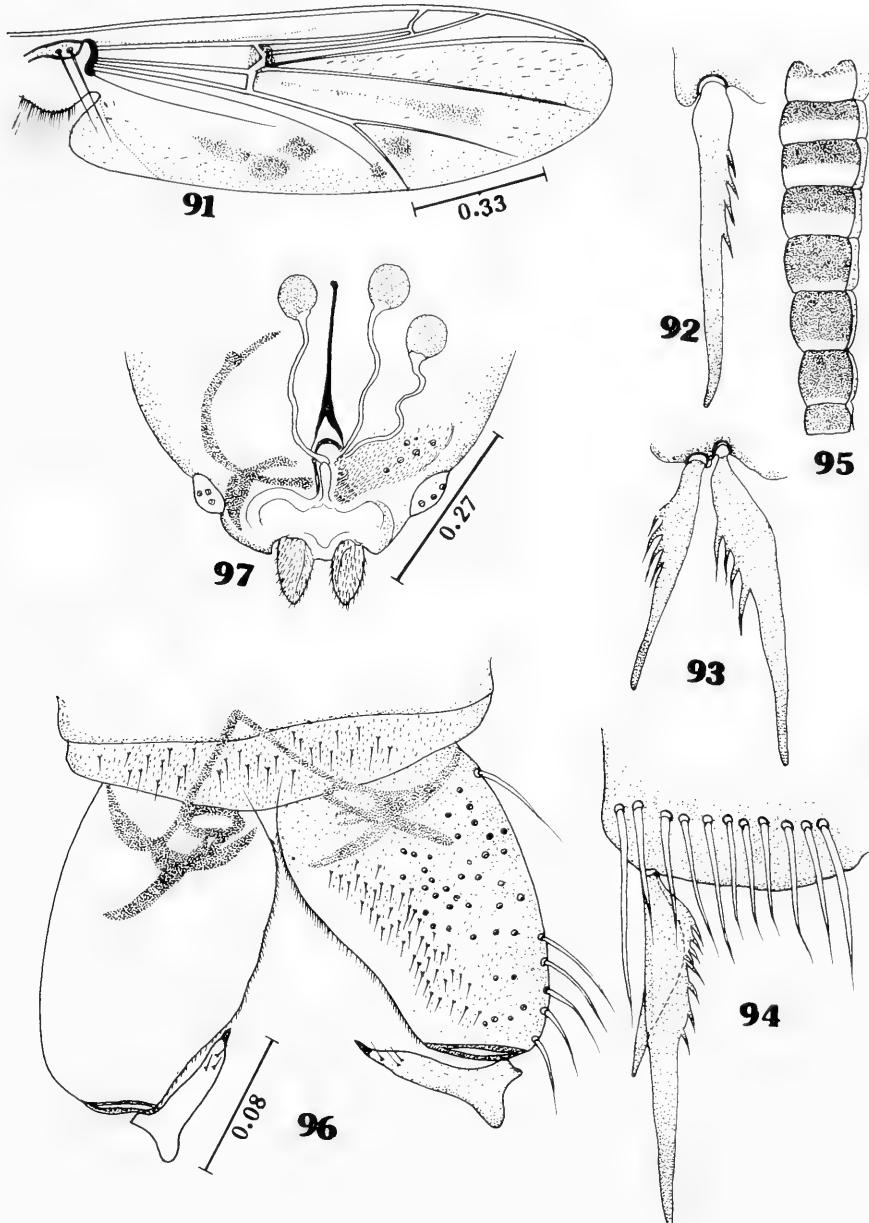
Figs. 67-73. Adult of *Clinotanypus fuscosignatus* (Kieffer). 67, Wing; 68, fore tibial spur; 69, mid tibial spur; 70, abdomen; 71, male hypopygium; 72, gonostylus of male; hypopygium; 73, female genitalia.



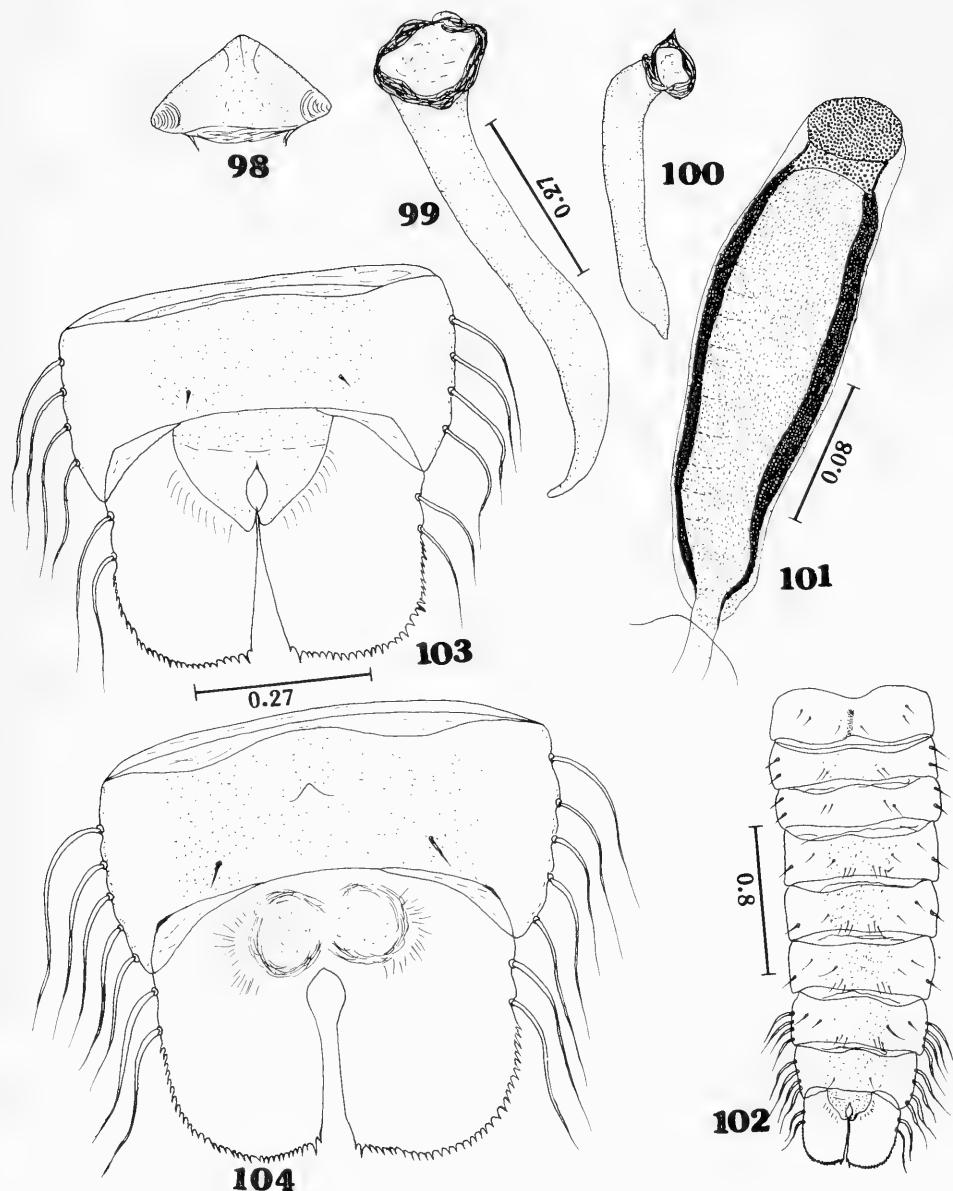
Figs. 74-80. Pupa of *Clinotanypus fuscosignatus* (Kieffer). 74, Frontal apotome; 75, antennal sheath of male; 76, antennal sheath of female; 77, thoracic horn; 78, abdomen; 79, anal fin and genital sac of male; 80, anal fin and genital sac of female.



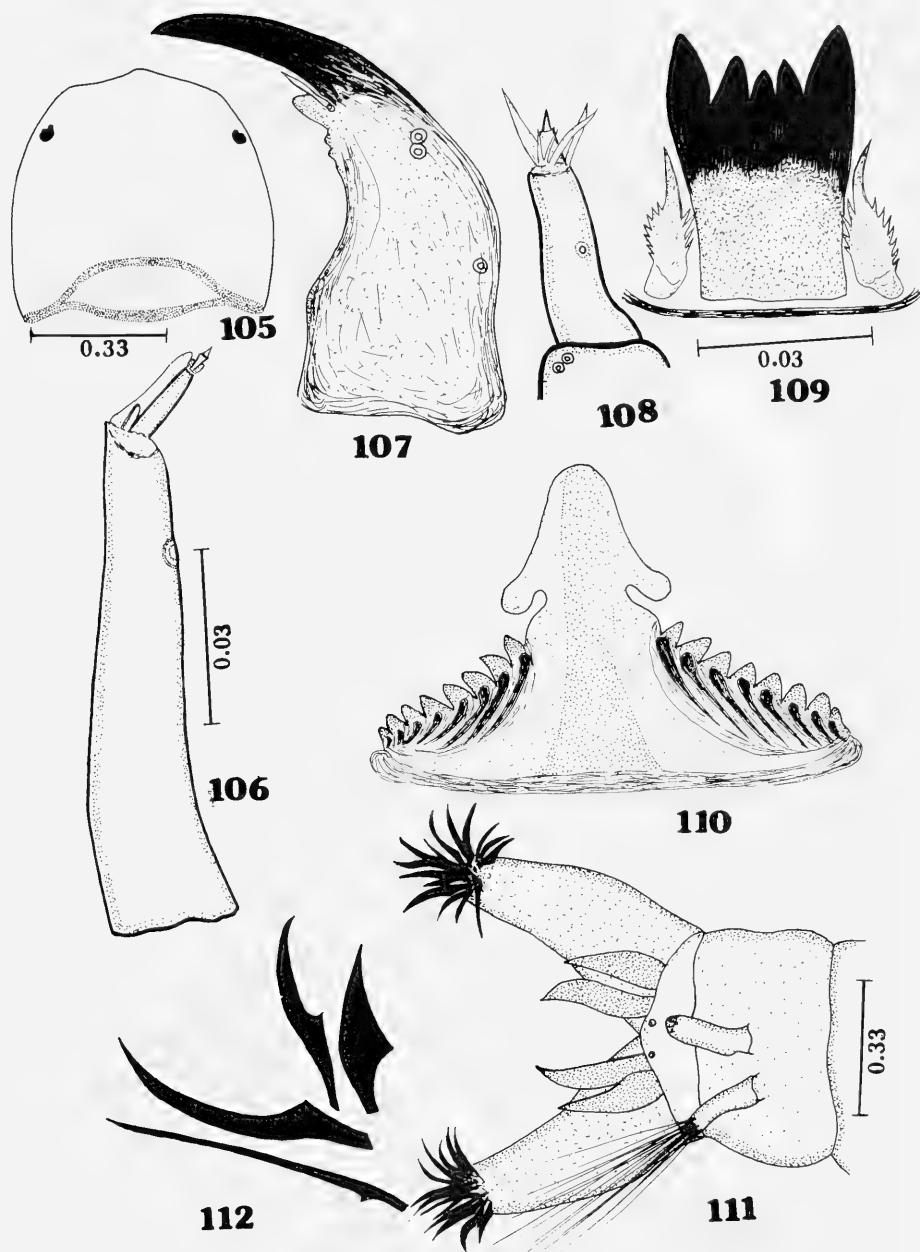
Figs. 81-90. Larva of *Clinotanypus fuscosignatus* (Kieffer). 81, Head capsule; 82, antenna; 83, apex of antenna; 84, mandible; 85, maxilla; 86, apex of maxilla; 87, ligula and pariligula; 88, mentum and M appendage; 89, posterior abdominal segments; 90, claws of posterior parapods.



Figs. 91-97. Adult of *Procladius noctivagus* (Kieffer). 91, Wing; 92, fore tibial spur; 93, mid tibial spur; 94, hind tibial comb; 95, abdomen; 96, male hypopygium; 97, female genitalia.



Figs. 98-104. Pupa of *Procladius noctivagus* (Kieffer). 98, Frontal apotome; 99, antennal sheath of male; 100, antennal sheath of female; 101, thoracic horn; 102, abdomen; 103, anal fin and genital sac in male; 104, anal fin and genital sac in female.



Figs. 105-112. Larva of *Procladius noctivagus* (Kieffer). 105, Head capsule; 106, antenna; 107, mandible; 108, maxilla; 109, ligula and paraligula; 110, mentum and M appendage; 111, posterior abdominal segments; 112, claws of posterior parapods.

NEW (SUB)SPECIES OF *DELIAS* FROM THE CENTRAL MOUNTAIN RANGE OF IRIAN JAYA (LEPIDOPTERA: PIERIDAE)

Mastrigt, H. J. G. van, 1990. New (sub)species of *Delias* from the central mountain range of Irian Jaya (Lepidoptera: Pieridae). – Tijdschrift voor Entomologie 133: 197-204, figs. 1-17. [ISSN 0040-7496]. Published 14 December 1990.

Delias sinak sp. n., *D. sigit* sp. n., *D. bobaga* sp. n. and *D. catocausta eefi* subsp. n. are described from the western part of the central mountain ranges in Irian Jaya, Indonesia. The recent acquisition of new *Delias* material from Abmisibil in the Star Mountains of Irian Jaya, leads to the recognition of the following new taxa: *D. oktanglap* sp. n., *D. wollastoni abmisibilensis* subsp. n., *D. luctuosa kuning* subsp. n. and *D. nieuwenhuisi poponga* subsp. n. *Delias nieuwenhuisi* nom. nov., a replacement name for *D. leucias roepkei* Nieuwenhuis & Howart (nec Benneth, 1956), is raised to specific rank.

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Keywords. – Lepidoptera; Pieridae; *Delias*; new species; Irian Jaya; Indonesia.

From the beginning of this century quite a few expeditions succeeded to enter the interior of Irian Jaya (former Dutch New Guinea). The butterflies of the genus *Delias* collected during these expeditions provided material for the description of new species from the Arfak Mountains, Weyland Mountains, Wissel Lakes, the surroundings of the Carstensz Peak, the Balieum Valley, Mt. Goliath and the Star Mountains.

The Star Mountains in Irian Jaya are one of the central mountain ranges of which no reports on *Delias* have been published. The results of the Dutch expedition to the Star Mountains in 1959 were poor and never published, as far as *Delias* is concerned. In fact, most information about *Delias* from the Star Mountains concerns the Papua New Guinea part of this range, where the late Ray Straatman and others collected at Telefomin, close to the Indonesian border. Results from the Papua New Guinea part of the Star Mountains are found in RMNH, BMNH and several private collections.

Since 1978 I have collected in the Star Mountains of Irian Jaya (fig. 17). The weather in these mountains is often cloudy and rainy, so that only small numbers of *Delias* can be collected in a short time, contrary to more western ranges of the central mountains where the weather is usually sunnier. Besides that, the mountains are rough and steep, which does not make travelling easy.

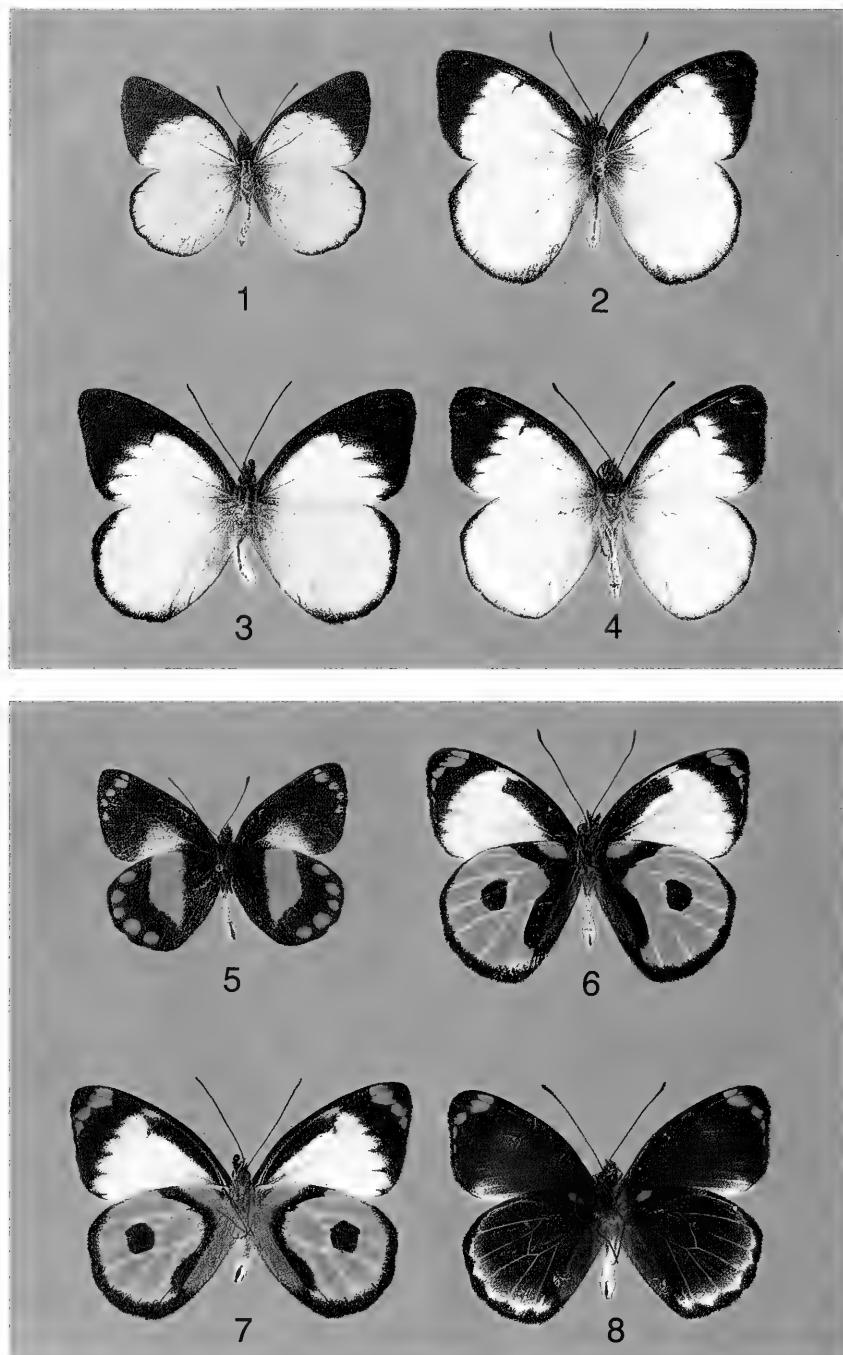
Further exploration of the extensive central mountain range of Irian Jaya, with its isolated val-

leys led to the discovery of new taxa.

In this paper three new species and one new subspecies from the western part of the central mountain ranges are described. My recent acquisitions of *Delias* from the Irian Jaya Star Mountains and study of additional museum material led to the recognition of one new species and three new subspecies from this area. Finally, a previously described subspecies is raised to specific rank.

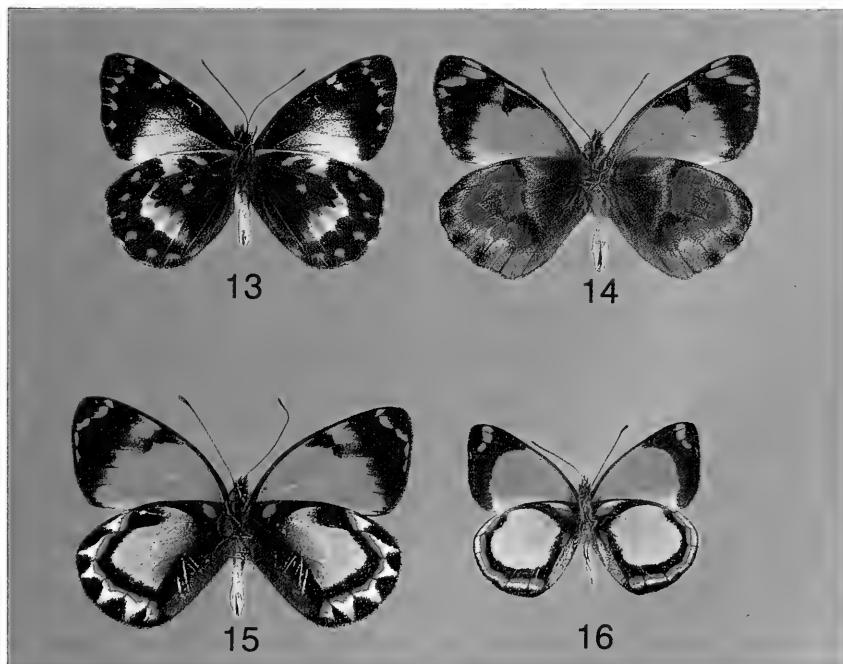
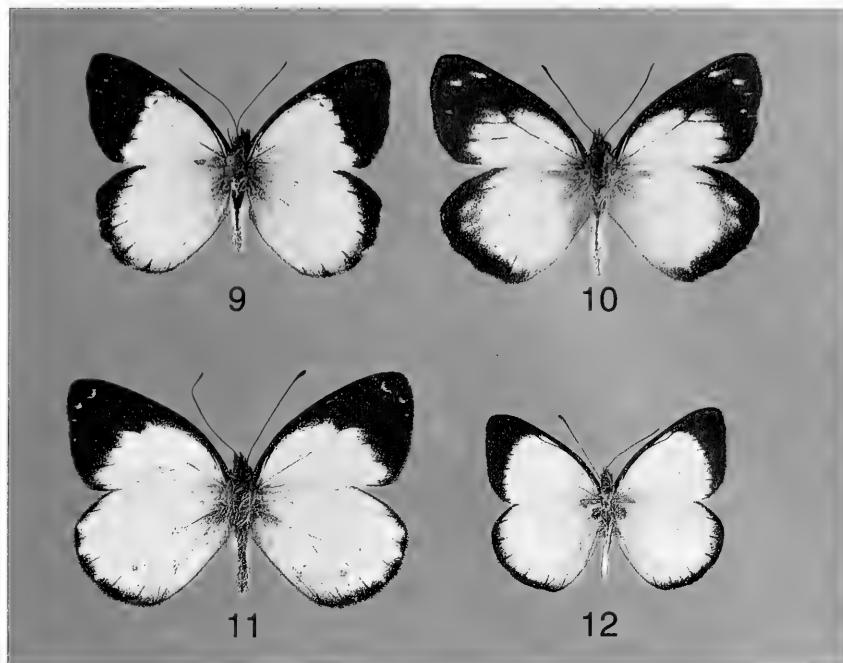
Depositories

The abbreviations given below have been used in the list of material and throughout the text.
BT – Private collection of Bernard Turlin, Andrésy, France; CT – Private collection of Collin Treadaway, Limbach, BRD.; DM – Private collection of David Mannering, Staplehurst, Kent, U.K.; DR – Private collection of David Rushen, E. Sussex, U.K.; ERII – Private collection II of Eduard Reissinger, Kaufbeuren, BRD.; GG – Private collection of Fred Gerrits, Brisbane, Australia; HM – Private collection of the author, Jayapura, Indonesia; MZB – Museum Zoologicum Bogoriense, Bogor, Indonesia.; RG – Private collection of Robert Gotts, Sidney, Australia.; RMNH – Nationaal Natuurhistorisch Museum (Rijksmuseum van Natuurlijke Historie), Leiden, The Netherlands; ZMA – Instituut voor Taxonomische Zoölogie (Zoölogisch Museum), Amsterdam, The Netherlands.



Figs. 1-4. New (sub)species of the genus *Delias*; uppersides of male holotypes. 1, *D. sinak*; 2, *D. sigit*; 3, *D. bobaga*; 4, *D. catocausta eefi*.

Figs. 5-8. New (sub)species of the genus *Delias*; undersides of male holotypes. 5, *D. sinak*; 6, *D. sigit*; 7, *D. bobaga*; 8, *D. catocausta eefi*.



Figs. 9-12. New (sub)species of the genus *Delias*; uppersides of male holotypes. 9, *D. oktanglap*; 10, *D. wollastoni abmisibilensis*; 11, *D. luctuosa kuning*; 12, *D. nieuwenhuisi poponga*.

Figs. 13-16. New (sub)species of the genus *Delias*; undersides of male holotypes. 13, *D. oktanglap*; 14, *D. wollastoni abmisibilensis*; 15, *D. luctuosa kuning*; 16, *D. nieuwenhuisi poponga*.

DESCRIPTIONS

Delias sinak sp. n.
(figs. 1, 5, 17)

Type material. – Holotype ♂: 'Irian Jaya, route Mulia – Sinak, vii.1989; don. Fr. Gerrits', ZMA. – Paratypes: same data as holotype, 2 ♂, GG; same data, but vii.1990, 6 ♂, GG; 4 ♂, HM; Mulia, ix. 1990, 7 ♂, GG; 3 ♂ MZB.

Diagnosis

This species belongs to a subgroup of rather small *Delias*, consisting of *Delias sagessa* Fruhstorfer, 1910 from East Papua New Guinea (including its subspecies *straatmani* Schröder, 1977 from Telefomin, Star Mountains and *anjae* Schröder, 1977 from the Arfak Mountains) and *Delias abrophora* Roepke, 1955 from the Paniai-district. These species are characterized by the black border of the hind wing underside, bearing five rounded red spots. The new species differs from these by the absence of the red spot at the base of the yellow (and white) discal band in the hind wing underside.

Description

Male. – Upperside fore wing white. Black border, with regularly curved inner edge, from discal cell at vein M_1 to margin border at 2A. Upperside of hind wing translucent white with narrow (1.5 mm) black border. Underside of fore wing black with a white area (some grey-black diffusion), from middle of tornus to vein CU_2 , sometimes entering discal cell, three subapical yellow spots followed by two marginal ones. Underside of hind wing black, 5 mm wide, yellow discal band from middle of tornus to vein 2A, becoming narrower from vein M_3 , not reaching anal border. Terminal border with five large, more or less round, red spots, slightly variable in size and shape.

Length of fore wing: 22 mm.

Female unknown.

Derivation of name. – 'Sinak': a noun in apposition. This butterfly occurs along the route from Mulia to Sinak and received its name from the latter locality.

Delias sitit sp. n.
(figs. 2, 6, 17)

Type material. – Holotype ♂: 'Irian Jaya/Centr. Bergland/Iлага, River Jila/ 7.vi.1988/Henk van Mastrigt' ZMA. – Paratypes: same data as holotype, 2 ♂, HM; same data but 9.iv.1988, 5 ♂, ZMA; 6 ♂, MZB; 22.v.1988, 4 ♂, HM; 2 ♂, BT; 27.viii.1988, 2 ♂, MZB; 2 ♂, HM; 1 ♂, BT; 2.v.1990, 2 ♂, HM; 4.v.1990, 3 ♂, HM; Ilaga, River Mum, 22.i.1989, 1 ♂, ZMA; Ilaga, 10.viii. 1988, 1 ♂, MZB; 1 ♂, HM; 1 ♂, BT; 1 ♂, GG; Mulia-Sinak, vi-vii.1989, 2 ♂, GG; Beoga, xii.1989, 7 ♂, GG; 1 ♂, HM; Mulia, ix. 1990, 10 ♂, GG.

Diagnosis

This species is similar to *Delias mariae* Jocey & Talbot, 1916 and *D. bobaga* because of its its bright and broad distal band on the hind wing underside, which is white with large orange patches. It differs from *D. bobaga* in lacking the large number of yellow scales in cells 2A and 3A of hind wing underside. It differs from *D. mariae* in having a yellow basal streak, which is connected to the white costal border. The basal streak of *D. mariae* sometimes with a small whitish edge, but the costa is black instead of white.

Description

Male. – Upperside of fore wing milky white with broad black costal border, entering discal cell, black LDC. Black border along termen, much broader at apex than at tornus and has slightly serrate inner edge, often with 1 or 2 subapical spots; second one very small. Upperside of hind wing milky white and translucent, narrow black border; whole pattern of underside visible from above. Underside of fore wing milky white with black border narrower than on upperside, three yellow subapical and one or two very small terminal spots. Large anterior part of discal cell black, passing LDC. Base of wing with some black and some blackish diffusion. Underside of hind wing yellow to yellowish orange with white veins, rounded black submarginal spot reaching LDC. Broad black anal part with some greyish green diffusion, connected to white costa, cutting off a yellow basal streak. Black border from SC+R₁ to 2A increasing in width from less than 1 mm to 3 mm.

Length of fore wing: 25-29 mm.

Female unknown.

Derivation of name. – 'Sigit', a noun in apposition. 'Sigit-sigit' is the vernacular word for butterfly, used by the Dani people in the Ilaga valley, where this butterfly occurs.

Delias bobaga sp. n.
(figs. 3, 7, 17)

Type material. – Holotype ♂: 'Kamu Valley, 1700 m, ix.1989, don. Henk van Mastrigt', ZMA. – Paratypes: same data, 1 ♂, MZB; 1 ♂, GG; 1 ♂, DM; Kamu Valley: Ekemanida, River Tuka & Enau, 1700-1800 m, 23-30.x.1990, 3 ♂, HM; River Mouna, 1.ii.1990, 5 ♂, GG; River Epugewo, 2.ii.1990, 1 ♂, GG; Idadagi, River Migu, 21.ii.1990, 1 ♂, HM; Idadagi, River Bedonaka, 20.iv.1990, 1 ♂, HM; River Budau, 10.xi.1989, 1 ♂, GG; River Ode, 2.ii.1990, 3 ♂, GG; Mapia area: River Okagou, 7.xii. 1989, 1 ♂, GG; 17.xii.1989, 1 ♂, HM; River Otika, 8.xii. 1989, 1 ♂, HM; River Yatuwou, 9.xii.1989, 1 ♂, GG; River Gudopena, 11.xii.1989, 1 ♂, GG; River Ude, 13.xii.1989, 1 ♂, GG; River Piayokowa, 1 ♂, GG; River Okagou & Yatuwou, 25-26.xi.1989, 1 ♂, HM; Mapia, River Iyage, 13.xii. 1989, 1 ♂, HM.

Diagnosis

This species is closely related to *D. sigit* sp. n., *Delias mariae* Joicey & Talbot, 1916 (including its subspecies *D. mariae boschmai* Roepke, 1955) and *D. mariae menoensis* Joicey & Talbot, 1922, with which it occurs together in the Kamu Valley. However, it differs from those in the large number of yellow scales in the cells 2A and 3A and in a much larger basal spot on the underside of the hind wing.

Description

Male. – Upperside of fore wing white to creamy white with broad, black costal border, entering discal cell, black LDC. Black border along termen, much broader at apex than at tornus and has a strongly serrate inner edge, sometimes absorbing black LDC. Upperside of hind wing creamy white and translucent with narrow black border; whole pattern of underside visible from above. Underside of fore wing milky white with black border, more reduced than on upperside, three red subapical spots and a red terminal one. Anterior part of discal cell black, via M_2 connected to black border, separating a small, yellowish spot. Underside of hind wing yellow with white veins and black submarginal spot just outside discal cell. From middle of costa a broad, curved, black line extends through inner part of discal cell along yellow green anal area to the bottom of cell CU_2 , where it is connected by a thin black line to the broad, black border, which runs from RS to 3A. Inner part of costa white. Base yellow with small black triangle at inner part.

Length of fore wing: 27-29 mm.

Female unknown.

Derivation of name. – 'Bobaga', a noun in apposition, is the vernacular word for butterfly used by the Ekagi people in the Paniai district, where this butterfly occurs.

Delias catocausta eefi subsp. n.

(figs. 4, 8, 17)

Type material. – Holotype ♂: 'Irian Jaya/Tembagapura 2000 m/17.xi. 1979/Van Mastrigt', ZMA. – Paratypes: same data, 1 ♂, DR; same data but 17.xi.1979, 1 ♂, HM; 1 ♂, MZB; Tembagapura, 2000 m, 1980, 2 ♂, RG; 1983, 1 ♂, GG; Tembagapura, River Wanogong, 2000 m, 1989, 1 ♂, HM.

Diagnosis

Apart from the nominate form *D. catocausta catocausta* Jordan, 1912, only *D. catocausta nigerima* Roepke, 1955 is known, from the Andrea River, just 50 km west of Mt. Goliath (c. 140° E.). The newly described subspecies is also from the southern side of the central mountain range of Irian Jaya, but occurs much more to the west: on the south sides of the Puncak Jaya (Carstensz Peak), c. 137°

E. It differs from the two above mentioned ones in the grey (instead of brown) ground colour on the underside of fore and hind wing, in the red (instead of yellow) colour of the basal spot on hind wing underside and in having white veins.

Description

Male. – Upperside of fore wing milky white, black tornus, thick, black LDC and black border along termen; this black border is much broader at apex than at tornus, has serrate inner edge and bears 2 poorly developed subapical spots. Basis of fore wing with some blackish diffusion. Upperside of hind wing milky white with very narrow black border. Underside of fore wing grey at innerside; the grey colour is connected by black veins to black border along termen; black border with three red subapical spots and two very small terminal ones. Inner edge of border serrate. A white band with some grey diffusion separates dark inner part from black border, widening from less than 1 mm on top to 7 mm along tornus. Underside of hind wing grey with white veins and small black spot close to discal cell on vein M_2 . Cell along costa, inner part of discal cell and cells 2A and 3A form a black hook with small red basal spot and greyish green diffusion along anal area in 3A. Narrow black border from cell RS to anal area is undulate at inner edge and separated from grey discal part by white line in cell RS, getting broader in M_1 , M_2 , CU_1 and somewhat narrower again in CU_2 . Border between this white line and grey innerpart vague and diffuse from M_1 till CU_2 .

Length of fore wing: 27 mm.

Female unknown.

Derivation of name. – This subspecies is named in honour of my father, the late Mr. Eef van Mastrigt, who awakened my interest in nature and especially in butterflies.

Delias oktanglap sp. n.

(figs. 9, 13)

Type material. – Holotype ♂: 'Irian Jaya/Sterren Geberge/Abmisibil 1920 m/ River Oktanglap/27.ii.1989/-Henk van Mastrigt', ZMA. – Paratypes: same data, 3 ♂, ZMA; same data, but 11.ix.1985, 4 ♂, HM; 12.ix.1985, 1 ♂, HM; 14-16.ix.1985, 6 ♂, ZMA; 2 ♂, HM; 1 ♂, ZMA; 6.vi.1986, 4 ♂, RMNH; 29.iv.1986, 1 ♂, HM; 2.v.1986, 1 ♂, HM; 22.x.1986, 4 ♂, RMNH; 2 ♂, HM; 17.vii.1987, 3 ♂, HM; 11.iii.1988, 2 ♂, MZB; 16-19.iii.1988, 7 ♂, ZMA; 3 ♂, BT; 20.iii.1988, 2 ♂, HM; Batimban, River Okkim, 1850 m, 14-16.ii.1987, Van Mastrigt, 6 ♂, RMNH; same data, but ix.1987, 2 ♂, ZMA; 19-21.iii.1988, 2 ♂, ZMA; 13-15.iv.1988, 1 ♂, BT; v.1988, 2 ♂, MZB; 19-20.viii.1990, 2 ♂, HM; Abmisibil, River Takpalngi, 17-25.ix.1988, 2 ♂, MZB; 1 ♂, BT; Abmisibil, River Okpeti, 1800 m, 14.ix.1986, 1 ♂, HM.

Diagnosis

This new species belongs to the *cuningputi* group, consisting of *D. cuningputi* (Ribbe, 1900), *D. konokono* Orr & Sibatani, 1986, *D. chimbu* Orr & Sibatani, 1986, *D. fascelis fascelis* Jordan, 1912, *D. fascelis ibelana* Roepke, 1955, *D. citrona* Joicey & Talbot, 1922 and *D. jordani* Kenrick, 1909, as defined by Orr and Sibatani (1986). It is distinguished from all those by its very reduced black border on the fore wing upperside and from *cuningputi* and *konokono* by its continuing submarginal light band on the hind wing underside.

Description

Male. – Upperside of fore wing white, black border from 1.5 mm outside discal cell to tornus, inner edge straight and slightly serrate. Very thin bar at top of discal cell. Upperside of hind wing white with black border from SC+R₁ to CU₂, 3 mm wide in M₁, narrowing to both ends. Underside of fore wing white in bottom 1/3, with black diffusion. Large black border connected with nearly totally black discal cell, enclosing three subapical yellow spots and three yellow to white marginal spots – with thin white line to margin border. Veins between discal cell and border partly black. Underside of hind wing black, divided by an irregular, 2-6 mm wide, curved white discal band, broken in M₁. Terminal border white with a yellow basal streak. Inner part of hindwing black with two yellow spots and some yellowish diffusion. On white discal band one yellow spot just above black connection, five yellow streaks in underpart. Black border with undulate edge at innerside, having a row of six yellow spots in a line with the above mentioned yellow spot and streaks on white band.

Length of fore wing: (25) 28 – 29 mm.

Female unknown.

Derivation of name. – 'Oktanglap' (a noun in apposition) is the name of the creek from where the holotype originates.

Delias wollastoni abmisibilensis subsp. n. (figs. 10 & 14)

Type material. – Holotype ♂: 'Irian Jaya/Abmisibil 1920 m/River Oktanglap/ 11.ix.1985/Van Mastrigt', ZMA. – Paratypes: same data as holotype, 1 ♂, HM; same data, but 1880-1920 m, 15.ix.1985, 1 ♂, HM; 22.x.1986, 1 ♂, MZB; 1 ♂, HM; 17-19. vii.1987, 1 ♂, ZMA.

Diagnosis

Adding this new subspecies from the Star Mountains in Irian Jaya, three separated populations of *Delias wollastoni* Rothschild, 1915 are now known, the other two being: *D. wollastoni wollastoni* from the southside of the Puncak Jaya (Carstensz Peak) (1 male in BMNH) and Beoga (1 male in GG) and *D. wollastoni bryophila* Roepke, 1955 from the

surrounding of Mt. Trikora (Mt. Wilhelmina) (good series of males in RMNH and ZMA and two males in HM). The new subspecies differs from the other two subspecies by its golden yellow colour of the fore wing underside and more vivid coloration of hind wing underside.

Description

Male. – Upperside of fore wing white, greyish black veins and some grey diffusion. Costal border black. Black border from top of discal cell to tornus encloses black LDC, two white subapical spots, two or three small terminal ones. Border reduced in cells M₃, CU₁ and CU₂ and slightly entering along dorsum. Upperside hind wing white with grey veins and some grey diffusion, particularly at inner edge of broad black border in cell M₁ and M₂. Underside of fore wing golden yellow, black border much narrower than on upperside, regularly curved at inner edge, encloses three large yellow subapical spots and five smaller yellow terminal ones. Costal border black; at top of LDC large black triangle which is narrowly connected to black border. Underside of hind wing with base and basal half of costa grey, bordered by SC+R₁. Large basal maroon coloured patch below SC+R₁, oblong patch on LDC and bowed, undulate postmedian band of same colour. Postmedian band consists of intervernal patches from RS to CU₂. Anal area densely covered with golden yellow scales; grey becoming pinkish grey in outer third of discal cell and in adjacent cells. A strong and rather straight median band extends from costa to 1A+2A, including the maroon brown streak on LDC. Space between this median and postmedian band filled with light pinkish grey, densely covered with dark grey-brown diffusion. Subterminal area light pinkish grey with darkenedermen, more or less dusted with golden-yellow scales mainly on tips of veins.

Length of fore wing: 29 mm.

Female unknown.

Derivation of name. – Abmisibil is the name of the village in the Star Mountains, which is close to the sites where this butterfly occurs.

Delias luctuosa kuning subsp. n. (figs. 11 & 15)

Type material. – Holotype ♂: 'Irian Jaya/Star Mountains/Abmisibil 1800 m/River Oktetro/11.ix.1985', ZMA. – Paratypes: Abmisibil, River Okmi, 31.iii.1985, Sam Monareh; 1 ♂, HM; Abmisibil, River Oktanglap, H. van Mastrigt, 1 ♂, HM; Langda, River Bibwe, 1800 m, 6.iv.1989, H. van Mastrigt, 1 ♂, HM; same data, but 17-19.iv.1989, 1 ♂, HM.

Diagnosis

Three populations of *D. luctuosa* Jordan, 1912 have been named previously, viz. *D. luctuosa arch-*

boldi Roepke, 1955 from the Baliem Valley (also from the more western Ilaga Valley), *D. luctuosa luctuosa* from Mount Groome, Papua New Guinea, and *D. luctuosa mizukamii* Okana, 1989 from Simbu Province, Papua New Guinea. With the new population from Langda and Abmisibil a bridge is made between the population from central Irian Jaya and the two populations from Papua New Guinea. The new subspecies differs from the three above mentioned in the golden-yellow colour of the male fore wing underside.

Description

Male. – Upperside of fore wing white with black costal border, slightly entering discal cell. Terminal border very broad in cells M_1 , M_2 and M_3 , narrower towards tornus, where it slightly curves along dorsum, provided with irregular inner edge, enclosing two small white subapical spots. Veins visible, particularly those on underside of discal cell. Upperside of hind wing translucent white with black border, which is narrow in cell RS and M_1 , undulate at vein M_2 and M_3 and broad in cells CU_1 , CU_2 and 2A. Underside of fore wing deep yellow, turning to white along dorsum, black border along inner edge in cell 2A. Costal border black. Large LDC connected to black border in cell M_3 , demarcating two yellow spots with black diffusion in cells M_2 and M_1 . Black border encloses three dark yellow subapical spots and two or three small terminal spots. Underside of hind wing with white ground-colour. Black costal border connected to broad black anal border, including small yellow pear-shaped basal spot. Postdiscal black band (width 3 mm) curving from anal border to costa at vein $SC+R_1$ and entering broadly cell RS; outer edge bordered with small red

line. White discal part with pink diffusion, darker at innerside; veins white. Discal border consists of five black triangles at veins, touching red line and demarcating six white, triangular to v-shaped, spots.

Length of fore wing: 27–29 mm.

Female unknown.

Derivation of name. – A noun in apposition. 'Kuning' is the Indonesian word for yellow and refers to the yellow underside of the fore wing, the characteristic feature of this butterfly.

Delias nieuwenhuisi nom. nov.

Delias leucias roepkei Nieuwenhuis & Howarth, 1969: 86.
Holotype ♂: Mandated New Guinea, Telefomin, 1700 m, 5.viii.1962 (Natuurhistorisch Museum, Rotterdam) (preoccupied by *D. mira roepkei* Benneth, 1956).

Discussion

Since the subspecific name *roepkei* in *Delias leucias roepkei* Nieuwenhuis & Howarth is preoccupied by Benneth's name, the replacement name *nieuwenhuisi* is proposed here, in honour of Mr. E. J. Nieuwenhuis, who was the first to describe this taxon. Further, since *nieuwenhuisi* and *leucias* s. str. are sympatric in the Star Mountains along river Okkim at Abmisibil, Irian Jaya and at Telefomin, Papua New Guinea, they cannot be regarded as subspecies of one species, therefore the first one is raised to specific rank: *D. nieuwenhuisi*.

The differences between the specimens from Telefomin (types of *nieuwenhuisi*) and those from Abmisibil lead to the recognition of two subspecies: *D. nieuwenhuisi nieuwenhuisi* from Telefomin and *D. nieuwenhuisi poponga* subsp. n. from Abmisibil (see below).



Fig. 17. Distribution of new (sub)species of the genus *Delias*. a, Kamu valley (type locality of *bobaga*); b, Tembagapura (type locality of *catocausta eefi*); c, Ilaga (type locality of *sigit*); d, Sinak (type locality of *sinak*); e, Langda (paratypes of *luctuosa kuning*); f, Abmisibil (type locality of *oktanglap*, *wollastoni abmisibilensis* and *luctuosa kuning*).

Delias nieuwenhuisi poponga subsp. n. (figs. 12, 16)

Type material. — Holotype ♂: 'Irian Jaya/Sterrengeberge/Batimban/ca 1900 m/ River Okkim, v.1988/H. van Mastrigt', ZMA. — Paratypes: same data, 9 ♂, HM; 1 ♂, ZMA; same data, but 24.xii.1985-7.i.1986, 3 ♂, HM; same data, but 1-5.v.1986, 14 ♂; 2 ♂, DR; 6 ♂, RMNH; same data, but 14-16.ii.1987, 6 ♂, ZMA; same data, but ix.1987, 7 ♂, HM; 1 ♂, BT; 6 ♂, ZMA; same data, but 19-21.iii. 1988, 14 ♂, HM; 6 ♂, BT; same data, but 13-15.iv.1988, 2 ♂, FG; 1 ♂, HM; 1 ♂, CT; same data, but 22.v-5.vi.1988, 2 ♂, HM; same data, but 11-13.viii.1988, 4 ♂, HM; same data, but vi.1986, 2 ♂, ERII; same data, but 19-20.viii.1990, 4 ♂, HM; 4 ♂, MZB; Takpalngi, 17-25.ix.1988, H. van Mastrigt, 6 ♂, HM; Ferohir, 5.v.1986, H. van Mastrigt, 1 ♂, ZMA.

Diagnosis

This subspecies differs from nominate *nieuwenhuisi* in three characters. Upperside and underside of fore wing having narrow black borders (even narrower than in *leucias*); having upperside of fore wing with a black vein, connecting border with midcell and underside of hind wing with a large posterior red strike and a thin anterior white line in the basal spot.

Description

Male. — Upperside of fore wing white with narrow black border, 5 mm in cell R_5 to 1 mm in cell CU_2 . Inner edge slightly serrate, not curved from cell R_5 to tornus. Black vein R_2 connects border with discal cell, demarcating a small white spot. Apical and marginal spots absent. Upperside of hind wing white, 1-2 mm wide, black border. Underside of fore wing yellow, narrow black border as broad as on upperside, having four yellow apical spots. Ground-colour orange yellow in cells R_5 , M_1 , M_2 , M_3 , and CU_1 , lemon yellow in discal cell and pale yellow to creamy white in cells CU_2 and 2A. Underside of hind wing with large creamy discal area, covering nearly whole discal cell and large inner parts of cells RS, M_1 , M_2 , M_3 and CU_1 , just entering cell CU_2 . Discal area surrounded by black line, which is less than 1 mm in cell RS, 2 mm in cell CU_1 and 3.5 mm in discal cell. Red subbasal mark usually oblong, sometimes more like an upside down 'v'. A 1 mm wide red line runs from cell $SC+R_1$ to CU_2 , parallel to and connected with black line which surrounds discal area. Discal border consists of a, 1.5 mm wide, white line, with at its outer edge a narrow black line from cell M_1 to CU_1 , which is more than 1 mm in cells M_3 and CU_1 only. Basal spot anteriorly white, posteriorly red. Anal margin appearing dirty pale yellow due to low number of black scales (compared to other species of this subgroup). Concentration of white scales along vein 3A divides yellow anal area.

Length of fore wing: 22-24 mm.

Female unknown.

Derivation of name. — A noun in apposition. 'Poponga' is the vernacular word for butterfly used by the people in the western part of the Star Mountains, where this butterfly occurs.

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REFERENCES

- Bennett, N. H., 1956. A new *Delias* from the central highlands of New Guinea (Lepidoptera, Pieridae). — The Entomologist 89: 81-83, pl. 3.
- Fruhstorfer, H., 1910. Familie: Pieridae, Weisslinge. — In: A. Seitz, Die Gross-Schmetterlinge der Erde 9: 123-135, 183-190, (1927) 1108.
- Jocey, J. J. & G. Talbot, 1916. New lepidoptera from Dutch New Guinea. — Annals and Magazine of Natural History (series 8) 17: 68-72.
- Jocey, J. J. & G. Talbot, 1922. New forms of the genus *Delias* (Pieridae) from New Guinea, Ceram and Buru. — Bulletin of the Hill Museum 1 (3): 303-319.
- Jordan, K., 1912. On new or little-known *Delias* from New Guinea. — Novitates Zoologicae 18 (1911): 580-593.
- Nieuwenhuis, E. J. & T. G. Howart, 1969. On some butterflies from the Indo-Pacific region. — Entomologische Berichten, Amsterdam 29: 85-88.
- Kenrick, G. H., 1909. Descriptions of some new species of the genus *Delias* from North New Guinea, recently collected by Mr. C. E. Pratt. — Annals and Magazine of Natural History (series 8) 4: 176-183, pls 6, 7.
- Okana, K., 1989. Descriptions of four new butterflies of the genus *Delias* (Lep.: Pieridae), with some notes on *Delias*. — Tokurana 14 (3/4): 1-6.
- Orr, A. G. & A. Sibatani, 1986. A revision of the *Delias aroae-cuningputi* complex (Lepidoptera, Pieridae) 1. The *D. cuningputi* group. — Tyô to Ga 37 (1): 1-14.
- Ribbe, C., 1900. Neue Lepidopteren aus Neu-Guinea. — Insektenbörse 17: 329-330.
- Roepke, W. K. J., 1955. The butterflies of the genus *Delias* Hübner (Lepidoptera) in Netherlands New Guinea. — Nova Guinea, n. s. 6 (2): 185-260.
- Rothschild, W., 1915. — In: W. Rothschild and J. H. Durant, Lepidoptera of the British Ornithologist's Union and Wollaston Expeditions in the snow mountains, southern Dutch New Guinea. — 168 pp. London, Hazell, Watson & Viney, Ltd.
- Schröder, H., 1977. Zwei neue *Delias* der *sagessa*-Gruppe aus Neuguinea (Lep., Pieridae). — Entomologische Zeitschrift Frankfurt am Mainz 87: 265-271.

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THE *TRIFURCULA SUBNITIDELLA* GROUP (LEPIDOPTERA: NEPTICULIDAE): TAXONOMY, DISTRIBUTION AND BIOLOGY

Nieuikerken, E. J. van, 1990. The *Trifurcula subnitidella* group (Lepidoptera: Nepticulidae): taxonomy, distribution and biology. – *Tijdschrift voor Entomologie* 133: 205–238, figs. 1–108, tab. 1. [ISSN 0040-7496]. Published 14 December 1990.

The nominal subgenus *Trifurcula* Zeller, 1848 is divided into two species groups: the *subnitidella* group and the *pallidella* group. The *subnitidella* group is described and comprises *T. subnitidella* (Duponchel, 1843), and eight new species: *austriaca* (from Austria), *luteola* (France), *puplesisi* (Soviet Union), *coronillae* (Spain), *victoris* (Spain), *josefklimeschii* (Italy, southern Europe), *iberica* (Spain) and *silviae* (France). Males of all species and females of six species are described and diagnosed, and for four species the larvae, mines and biology are described as well: they make mines in stems of herbaceous or shrubby Fabaceae (tribes Loteae, Coronilleae). The group is widespread in the western Palaearctic, but most species occur in Southwest Europe. *T. subnitidella* is recorded for the first time from 14 countries. The phylogeny of the group and subgenus are discussed, the *pallidella* group is considered to be its sistergroup. A lectotype for *T. orientella* Klimesch, previously confused with some species here described, is designated.

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Keywords. – Nepticulidae, stem-miners, taxonomy, phylogeny, Palaearctic, Fabaceae.

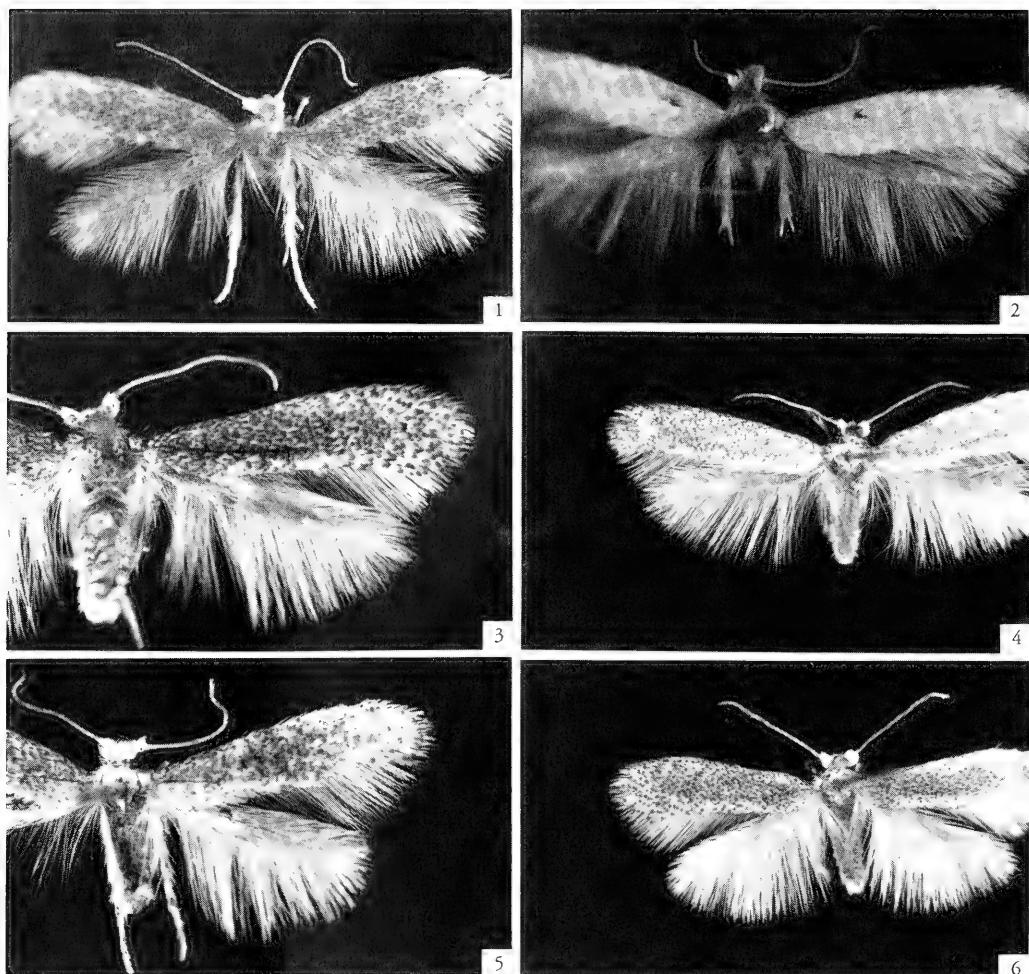
The genus *Trifurcula* Zeller, 1848 constitutes an important part of the nepticulid fauna of the Mediterranean region with the total number of species probably exceeding 60 (31 described species: van Nieuikerken 1986a). It is especially abundant in dry open habitats, such as grasslands, maquis and garigue vegetations, where the larvae make leaf- or stem-mines in shrubby and herbaceous plants, in particular Lamiaceae (Labiatae) and Fabaceae (Leguminosae). A few species extend their ranges northwards into northern and western Europe. *Trifurcula* remains the main nepticulid taxon in Europe which needs extensive taxonomic revision.

The genus was fully redescribed by van Nieuikerken (1986b), who recognized three subgenera: *Glaucolepis* Braun, *Levarchama* Beirne and *Trifurcula* Zeller. The ten Northwest European species have been treated by van Nieuikerken & Johansson (1990), but no comprehensive work for the remaining European species is currently available.

The present paper is the first in a series of revisions of *Trifurcula*, which follows a few papers dealing with single species (van Nieuikerken & Johansson 1986, van Nieuikerken 1987). The subgenus *Trifurcula* was revised by Klimesch (1953), who recognized eight species, two of which are now considered to be junior synonyms. Only two species

were added later, *T. griseella* Wolff, 1957 (later recognized to be a junior synonym of *T. subnitidella* (Duponchel, [1843])) and *T. beirnei* Puplesis, 1984, resulting again in a number of eight described species (van Nieuikerken 1986a). These species only represent a minority of the actual number, which probably exceeds 25.

The described species are almost all relatively uniformly coloured moths, without striking external characters, and associated with various species of brooms (Fabaceae, tribe Genisteae). *T. subnitidella* forms an exception in having a conspicuous external character – a band of bright yellow scales on the male forewing underside – and having an association with herbaceous Fabaceae (*Lotus*: van Nieuikerken & Johansson 1990). In unidentified and misidentified material from southern Europe and western Asia eight species with similar external features have been found, and following recent field trips three of these species and *T. subnitidella* itself, have been reared from larvae collected on plants belonging to the tribes Loteae and Coronilleae. In this paper these species are assembled into the *T. subnitidella* species group, whereas the other palaearctic species in *Trifurcula* s. str. (with the type species *T. pallidella* (Duponchel, [1843])) are considered to form the *T. pallidella* species group.



Figs. 1-6. *Trifurcula* spp., male habitus. - 1, *T. austriaca*, holotype; 2, *T. luteola*, paratype from type-locality; 3, *T. coronillae*, holotype; 4, *T. victoris*, holotype; 5, *T. subnitidella*, Spain, Camino de Ojen; 6, *T. josefklimeschii*, holotype.

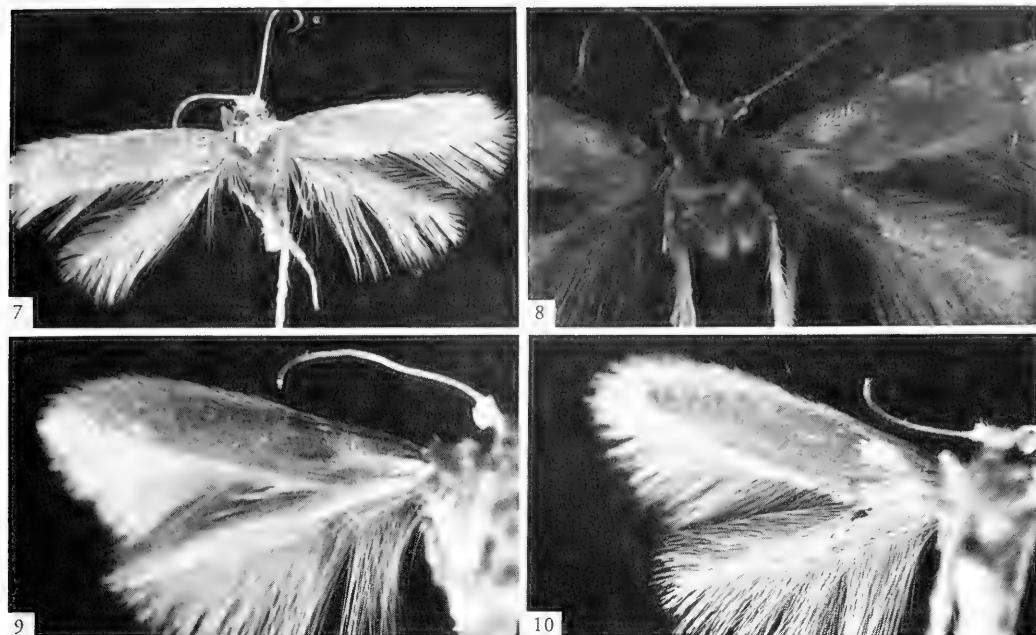
When studying the material, representing the new species below, several specimens were found to be labelled as *T. orientella* Klimesch, 1953. This led me to re-examine *T. orientella* and select a lectotype for this species, which clearly belongs to the *pallidella* group. Other specimens treated here were found amongst material labelled as '*T. immundella* (Zeller)', '*T. pallidella* Zeller', '*T. serotinella* Herich-Schäffer' and '*Nepticula cryptella* Frey'. Apparently, previous workers rarely examined the underside of the forewings of these tiny moths, which exhibit such good characters in this group.

MATERIAL AND METHODS

Larvae were collected by cutting portions of the stems of the hostplant, containing the mines. The

stems were put in plastic boxes with a layer of paper tissue, in which the larvae could spin their cocoons. Next the cocoons or full-grown larvae were transferred into glass jars with a layer of soil and some moss. In the case of species from southern Europe, these jars were kept indoors (in The Netherlands), at room temperature, until emergence. Autumn collected larvae of *subnitidella* were, after spinning their cocoons, left in an outhouse for overwintering, and were brought indoors in March.

Methods for preparation of the genitalia are largely the same as in van Nieuwerken (1985). In this group it is often very difficult to separate the aedeagus from the genitalia capsule and valvae, because of the tight connection with membranes. The aedeagus has therefore only been severed in some specimens, in order to study the complex morphol-



Figs. 7-10. *Trifurcula* spp., males. – 7, *T. silviae*, habitus, holotype; 8, *T. austriaca*, underside, holotype; 9, *T. subnitidella*, underside, Spain, Camino de Ojen; 10, *T. coronillae*, underside, holotype. Andraconial patch arrowed in figs. 8-10.

ogy of aedeagal processes and cornuti; in some specimens also the vesica was removed from the aedeagal tube to show the cornuti better. For identification purposes, removing of the aedeagus is not always necessary.

Larvae were treated with KOH 10% prior to cleaning and mounting with Euparal on slides. They were stained with Chlorazol black.

Line figures of genitalia were prepared with a Zeiss Standard microscope or Zeiss Axioskop, with camera and drawing apparatus, both from genitalia in glycerin and permanent mounts. In most cases cornuti are drawn separate from the aedeagus; only the characteristic larger cornuti are depicted, the smaller ones being almost similar in all species. Line drawings of mines were made from herbarium specimens, after boiling for some minutes in distilled water: frass may be better visible in such soaked mines than in fresh ones.

Photographs of genitalia and larval head capsules were taken with a Zeiss Axioskop microscope and camera.

SEM micrographs were taken with a Jeol JSM 840A scanning electron microscope. Specimens were air-dried, mounted on stubs and gold-coated.

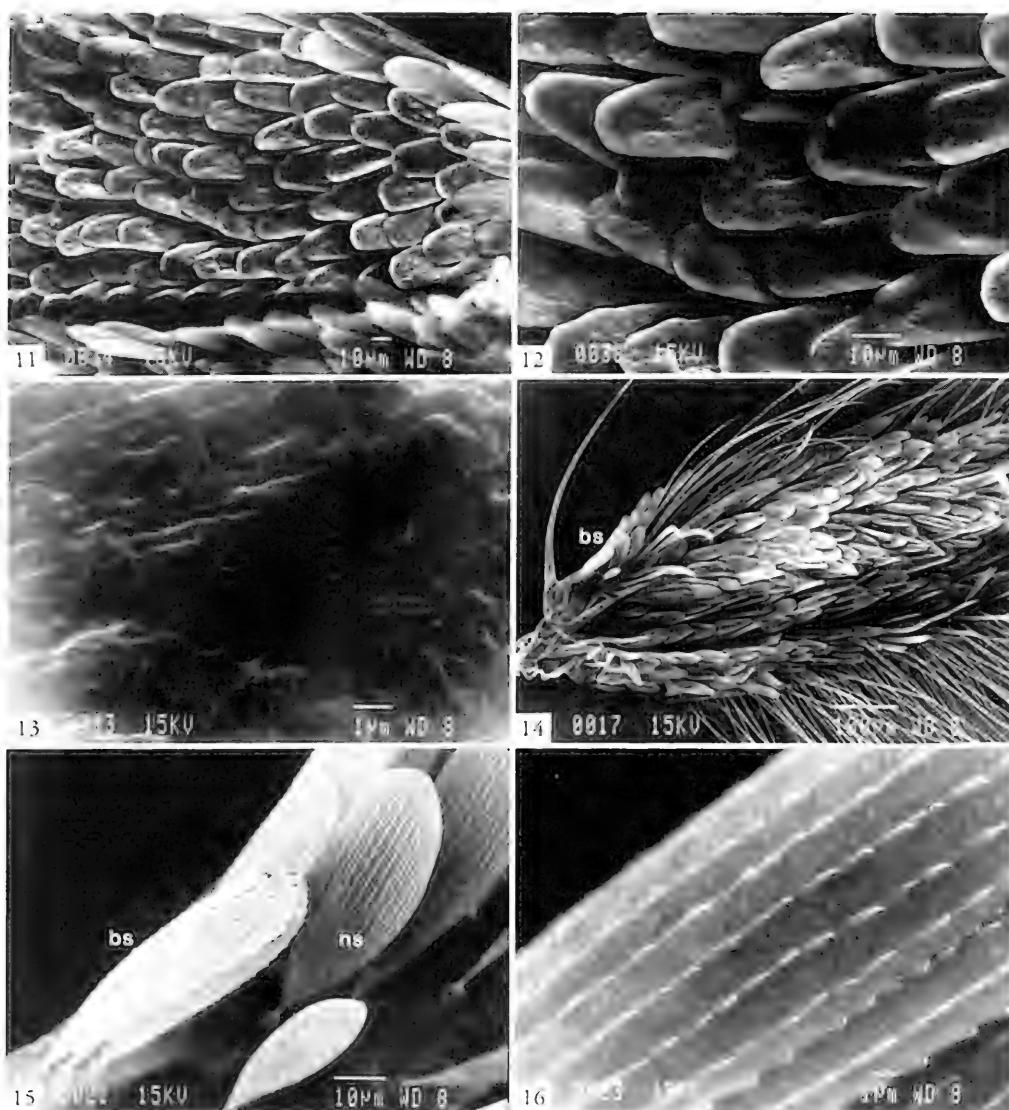
Measurements of genitalia are taken with a Zeiss Axioskop or Universal Microscope, at 200 \times , and are accurate at the nearest 5 μm . All measurements based on sample size of at least five specimens are

accompanied by mean, standard deviation and sample size in brackets.

Distribution maps are based on material examined, but for *T. subnitidella* also literature data and personal communications have been used. Locality names are spelled in accordance with the Times Atlas of the World (Comprehensive edition, 1975 and later), deviating names on labels are cited in brackets. For all localities the appropriate UTM grid references (10×10 km, or 1×1 km for authors' records) are given. These are used for plotting the distribution on the 50×50 km squares of the maps provided by the 'European Invertebrate Survey'. The UTM grid references were obtained directly from 'Tactical Pilotage Charts 1:500,000', topographical maps, or calculated from geographical coordinates (obtained from atlases, various maps or US gazetteers), using the computer program 'UTM' by Rasmont & André. Most of the British records, however, are an approximation of the correct UTM square, since they are based on vice-county records and dots on a vice-county map, provided by A. M. Emmet (in litt.).

Nomenclature of hostplants follows Heywood & Ball (1968), but the family name Fabaceae is used in stead of Leguminosae.

Abbreviations (codens) for depositories follow Arnett & Samuelson (1986), with the addition of: ETO (for collection E. Traugott-Olsen, Marbella,



Figs. 11-16. *Trifurcula subnitidella*, male, details of wings, scanning micrographs. – 11, forewing underside with yellow scale patch, some normal wing scales in upper right corner; 12, 13, details of androconial scales; 14, hindwing with frenulum and group of 'black' scales; 15, idem, detail; 16, ultrastructure of 'black' scale. bs = black scales; ns = normal scale.

Spain), GBA (for collection G. Baldizzone, Asti, Italy) and ZKVV (Zoologijos Katedra VPI, Vilnius, Lithuania). Note that in the index of Arnett & Samuelson the coden NHMW is misspelled as NHMV. RMNH remains the coden for the National Museum of Natural History, Leiden, Netherlands (formerly Rijksmuseum van Natuurlijke Historie). Genitalia slide numbers refer to the numbering system of the author, unless accompanied by another abbreviation.

TAXONOMIC PART

For descriptions of the genus *Trifurcula* Zeller, 1848 and its typical subgenus refer to van Niekerken (1986b) and van Niekerken & Johansson (1990). This subgenus is here divided into two species groups, recognized according to the following key:

1. Forewing underside in male with a patch of yellowish androconial scales near base (except in *T. silviae*); in addition hindwing costa often with row or group of dark brown or black special scales. Male genitalia: gnathos often atypical: either with serrations, keels, projections or completely asymmetrical, occasionally simple and symmetrical. Aedeagus usually with dorsal lobe at right side; large cornuti (3) not curved and horn-like (except in *austriaca*). Larvae stem-miners in tribes Loteae or Coronilleae (Fabaceae)..... *subnitidella* group

- Forewing underside and hindwing costa in male without androconial or special scales. Male genitalia: gnathos simple, symmetrical. Aedeagus usually with dorsal lobe at left side; at least one or two large cornuti strongly curved, horn-like. Larvae stem-miners in brooms: tribe Genistae .. *pallidella* group

The following nominal species are here assigned to the *pallidella* group: *Trifurcula pallidella* (Duponchel, [1843]) (= *incognitella* Toll, 1936), *T. immundella* (Zeller, 1839), *T. serotinella* Herrich-Schäffer, 1855 (= *confertella* Fuchs, 1895), *T. orientella* Klimesch, 1953, *T. aurella* Klimesch, 1953, *T. beirnei* Puplesis, 1984 and *T. squamatella* Stainton, 1849 (= *maxima* Klimesch, 1953). Also the undescribed species from Sumatra (see van Nieuwerken 1986b) belongs here. This group will be the subject of a future revision.

The *Trifurcula subnitidella* group

Description

Adult (figs. 1-7). – Forewing length 2-3.5 mm. Antenna with 27-48 segments, in male with more flagellar segments than in female. Forewing underside uniformly pale or irrorate by dark tipped scales, mixed with pale scales. No other colour pattern present. Venation as described for subgenus (van Nieuwerken 1986b, van Nieuwerken & Johansson 1990).

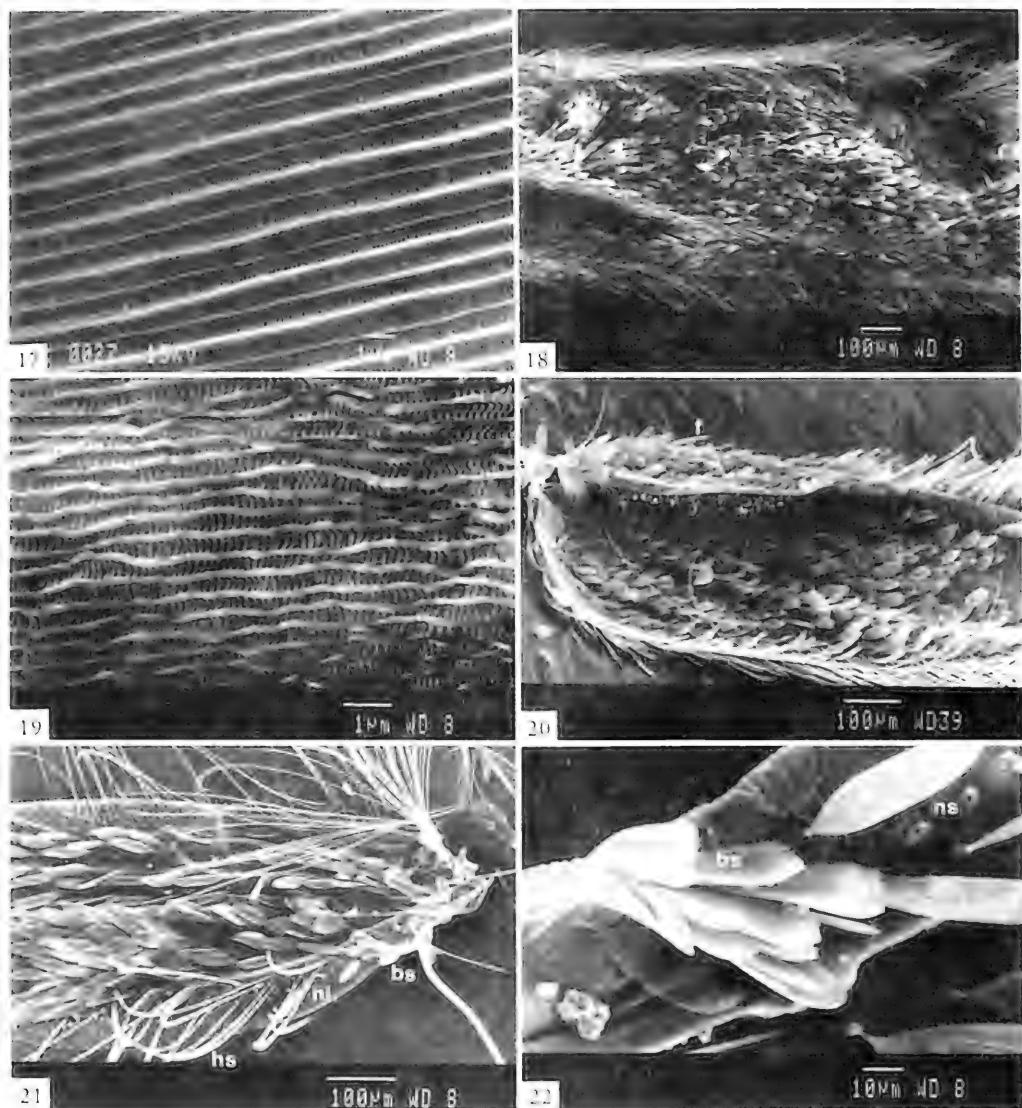
Underside of forewing in male with a distinct patch of lamellar androconial scales near wing-base (figs. 8-10), usually yellow or yellowish white, occasionally with various tinges of yellow (this patch is absent in *T. silviae*). The patch consists of scales, which are ultrastructurally different from normal wing scales (fig. 11) (see also van Nieuwerken et al. 1990). In *subnitidella* these scales have almost no ultrastructure (figs. 12, 13), although remnants of scale-ribs are visible on some scales. In *coronillae* the three differently coloured areas also appear to have different ultrastructure: the basal area is much similar to the patch of *subnitidella* (not illustrated), but the scales in the central area have an irregular pattern of ribs (fig. 19). Forewing costa often with

distinct costal fold on underside, in *josefklimeschi* extremely large (figs. 20, 58).

Hindwing underside in male with terminal velvet-like patch of raised scales (generic character) (illustrated by van Nieuwerken 1986b and van Nieuwerken et al., 1990). Costa of hindwing in several species slightly enlarged (fig. 21), in some species provided with a short or longer row of distinct black androconial scales (figs. 57-60). These scales also differ ultrastructurally from normal wing scales (figs. 15, 16, 22). In fig. 15 both the black scales and normal wing scales are shown, the ultrastructure of the normal scale is illustrated in fig. 17. The androconial scales are completely jet-black, or dark-brown in *silviae*, and have spiny ribs, with the intercalary area almost devoid of structure, apart from some indistinct bulges (fig. 16). Male without costal bristles, but often with long white hair-scales instead.

Male genitalia (figs. 23-88 in part). – Vinculum anteriorly rounded, truncate or slightly concave. Uncus with central process pointed or terminally widened, occasionally bilobed. Gnathos occurs in two forms: either symmetrical, with rounded or triangular central element, or asymmetrical and complex, provided with keel(s) or with serrate margin or with a combination of both; anterior apodemes usually present, but not always well sclerotized. Valva elongate, more or less triangular, or in some species with broader basal part. Aedeagus joined by juxta (ventral process) to valvae and capsule. Aedeagal tube asymmetric, complicate, tapering posteriorly both in lateral and ventral view; ventrally ending in a pointed or serrate (fringed) medial carina, which hinges to the juxta, dorsally ending in a pointed or spatulate tip, often indistinct, and in addition usually with a dorsal lobe at right-hand side, in *austriaca* at left-hand side. Vesica with complex set of cornuti: a group of about 10-20 long needle-like cornuti at right-hand side (dorsally in lateral view), many smaller cornuti of variable shape spread throughout vesica and usually three larger cornuti near phallotrema: a long smooth spine, often protruding from phallotrema, basally connected to a smaller cone-shaped cornutus; in addition another large, often irregular cornutus is often hidden amongst the group of spine-like cornuti, it may also protrude from the aedeagal tube. Sometimes both large cornuti are very similar, and other cornuti may be more reduced in size and number. In *coronillae* the dorsal lobe has a spiny process, which in normal slides is inseparable from the cornuti (fig. 49).

Female genitalia (figs. 89-100). – In general as in (sub)genus. Terminal segments either broad and blunt, or slightly pointed. Ductus bursae relatively wide; corpus long, covered with minute pectinations; signa usually long and narrow: a thickened margin encloses some rows of complete cells, out-



Figs. 17-22. *Trifurcula* spp., male, details of wings. - 17, *T. subnitidella*, ultrastructure of normal wingscale from fig. 15; 18, *T. coronillae*, forewing underside with yellow patch, different areas numbered from wingbase; 19, idem, ultrastructure of scale from area 2; 20, *T. josefklimeschi*, forewing underside with costal fold and androconial scale patch underneath; 21, idem, hindwing with humeral lobe and 'black' scales, costal margin below; 22, idem, detail. bs = black scales; f = fold; hl = humeral lobe; hs = hairscales.

side this margin there is a row of incomplete larger cells. Ductus spermathecae with less than 5 coils.

Final instar larva (figs. 101-104). - Body extremely elongate, deep yellow in colour. Head with frontoclypeus almost rectangular, tentorial arms short. Labrum with two pairs of setae: a medial and a lateral. Labial palpi three segmented. Antenna with sensilla not cross-wise. Prothorax with small ventral sclerite and a pair of narrow dorsal sclerites. Thorax with respectively 13, 12 and 10 setae pairs,

abdominal segments 1-8 with 6, segment 9 with 3 and 10 with 2 setae pairs in all species examined. Integument with reduced spinosity, usually only spines ventrally and laterally upwards to the spiracles; spines usually short and inconspicuous. Anal rods posteriorly bifid. The four species described below can hardly be distinguished as larva, except by size, length/width ratio of the headcapsule and slight differences in spinosity.

Diagnosis

Males of the *subnitidella* group are recognized by the presence of a yellow androconial patch on the forewing underside, in some species in combination with black scaling along the hindwing costa. In *T. josefklimeschii* the patch is hidden under a large costal fold, in *silviae* the patch is absent, but there are rows of dark brown to black scales along the margin of the forewing costal fold and along the hindwing costa. Males of several species in the subgenus *Glaucolepis* Braun (such as *T. stoechadella* (Klimesch) and *T. saturejae* (Parenti)) also have patches of androconial scales on the underside of the forewing: they are either farther away from the wing base or extend over almost the whole wing surface; these species also differ in venation and genitalia (see van Nieuwerken & Johansson, 1990).

Females cannot be differentiated externally from other *Trifurcula* species. The female genitalia differ from other *Trifurcula* s. l. species by a combination of the typical shape of signa as described above and the relative short ductus spermathecae with few coils. However, some species of the *Trifurcula pallidella* group have similar female genitalia.

Biology

The biology of this group has not been described prior to the recent discovery of the biology of *T. subnitidella* (van Nieuwerken & Johansson 1990). The hostplant and larva of four of the species described here are known through rearing. The larvae of these species make stem-mines in herbaceous or shrubby species of Fabaceae, belonging to the genera *Lotus*, *Dorycnium*, *Anthyllis* or *Coronilla*, see table 1. The stem-mining species of this group are often sympatric with and feeding within centimeters of leaf-mining species of the subgenus *Trifurcula* (*Levarchama*), which have a very similar host-range: on *Lotus* we find *T. subnitidella* together with either *T. (L.) eurema* (Tutt) or *T. (L.) cryptella* (Stainton); on *Dorycnium*, *T. josefklimeschii* occurs together with *T. (L.) eurema* and on *Anthyllis cytoides* we found *T. victoris* on the same plants as *T. (L.) anthyllidella* Klimesch. Hitherto all species of the *subnitidella* group are found on a single hostplant genus only.

The egg is deposited on the stem of the host, in one species on a leaflet. The larvae make relatively straight gallery mines in the green bark of the stem, usually changing direction of feeding several times (figs. 105-107). Larvae feed with their venter towards the epidermis. The full-grown larva quits the mine through a semicircular slit, and spins a cocoon on the soil or in leaf-litter.

The life history is still incompletely known. It is assumed here that most species are univoltine, albeit with a long flight period, but bivoltinism is not excluded, and well possible for *T. subnitidella* and *josefklimeschii*. The mediterranean species have

Table 1. Hostplants of *Trifurcula subnitidella* group, all in family Fabaceae (Papilionaceae).

Hostplant	species of <i>Trifurcula</i>
Tribus Loteae	
<i>Dorycnium hirsutum</i> (L.) Ser.	7. <i>T. josefklimeschii</i>
<i>D. pentaphyllum</i> Scop.	7. <i>T. josefklimeschii</i>
<i>Lotus corniculatus</i> L.	6. <i>T. subnitidella</i>
<i>Anthyllis cytoides</i> L.	5. <i>T. victoris</i>
Tribus Coronilleae	
<i>Coronilla juncea</i> L.	4. <i>coronillae</i>

been collected as larvae in January, February and April, and *T. subnitidella* larvae have been found in September and October in The Netherlands. Most specimens of *subnitidella* and *josefklimeschii* emerged within a short period, but *T. coronillae* and *victoris* specimens emerged over a period of several months.

Although the hostplant and immature stages of the other five species are unknown, it is tentatively assumed that they feed on related hostplants (herbaceous Fabaceae) and make stem-mines as well. The first assumption is supported by the localities of several of these species: they have been found in grassland habitats without any species of broom, the most likely alternative hosts in this subgenus. *T. iberica* and *silviae* have been found in alpine meadows, where herbaceous Fabaceae are abundant and *T. puplesia* occurs in western Asia, beyond the natural range of broom species.

Adults of the *subnitidella* group have been collected by sweeping in grasslands and at light. They are, however, easily overlooked, and the search for mines is a more secure way to obtain records.

Distribution

The group has a wide distribution in the western Palaearctic region, but only *T. subnitidella* is widespread. The other species center around the Mediterranean, currently with the highest number of species in Spain (5), southern France (3) and eastern Austria (3). One species, *T. puplesia*, has a much more eastern distribution: around the Caspian Sea and in the western part of the Central Asian deserts, it is the easternmost Palaearctic species of *Trifurcula* s. str. The scarcity of records from Greece and northern Africa presumably is biased by collecting activities.

Checklist of the *Trifurcula subnitidella* group

Trifurcula Zeller, 1848
subgenus *Trifurcula* s. str.

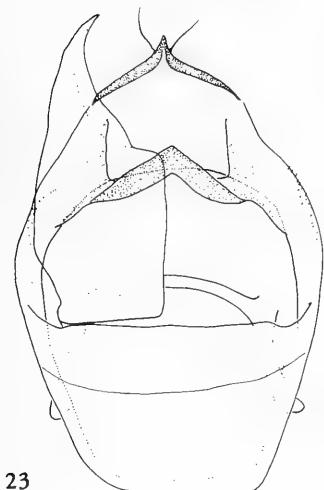
subnitidella species group

1. *austriaca* sp. n.
2. *luteola* sp. n.
3. *puplesisi* sp. n.
4. *coronillae* sp. n.
5. *victoris* sp. n.
6. *subnitidella* (Duponchel, 1843)
 griseella Wolff, 1957
7. *josefklimeschii* sp. n.
8. *iberica* sp. n.
9. *silviae* sp. n.

Key to the males of the *Trifurcula subnitidella* group

1. Underside of forewing with a well exposed patch of yellow(ish) androconial scales near wing base (figs. 8-10). Hindwing costa with or without some black scales 2

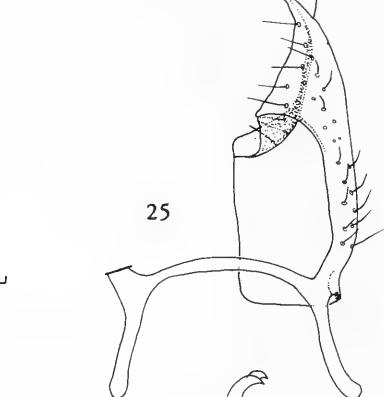
- Underside of forewing with large costal fold, hiding the distinct androconial patch (figs. 20, 58). Hindwing costa with enlarged lobe, a small group of black scales just behind frenulum (fig. 58)..... 7. *T. josefklimeschii*
- Underside of forewing without yellow patch, but margin of costal fold with row of dark-brown or black special scales; a row of similar scales along hindwing costa (fig. 60). Pale alpine species..... 9. *T. silviae*
- 2. Yellow patch divided into three well-separated areas with different tinges: from yolk yellow, through yellowish white to grey-brown (figs. 10, 18). Hindwing costa without black scaling 4. *T. coronillae*
- Yellow patch with only one colour. Hindwing costa with or without black scaling..... 3
- 3. Hindwing costa with black scales extending from about $\frac{1}{4}$ to $\frac{1}{2}$ (fig. 59)..... 8. *T. iberica*



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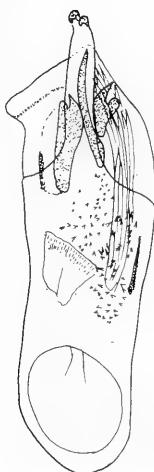
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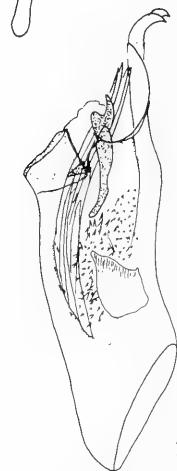
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Figs. 23-28. *Trifurcula austriaca*, male genitalia holotype, slide 2591 (except fig. 28). - 23, Capsule, valva outlined; 24, Juxta; 25, Valva, dorsal aspect; 26, Larger cornuti from paratype, slide Klimesch 757, slightly squashed; 27, Aedeagus, ventral aspect; 28, Idem, lateral aspect. Scale 0.1 mm.

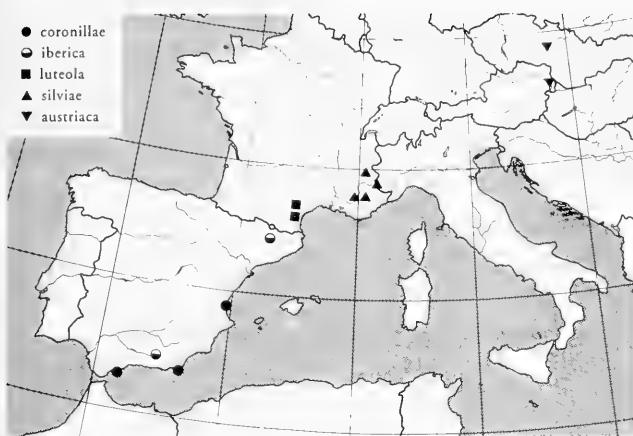


Fig. 29. Distribution of *Trifurcula* species, see legend. Mapped on 50 × 50 km UTM squares.

- Hindwing either with very small group of black scales near frenulum or without such scales 4
- 4. Hindwing costa with a small row of black scales just behind frenulum (fig. 57) (difficult to detect). Antenna with 31-36 segments. Gnathos asymmetrical, with a small keel at right side (fig. 61) 6. *T. subnitidella*
- Hindwing costa completely without black scaling. Antenna with 34-48 segments. Gnathos either asymmetrical with two keels, or symmetrical 5
- 5. Small species (forewing length 2.6-2.9 mm), with 34-37 antennal segments. Androconial patch (fig. 8) yellowish white, similar scales also present on hindwing upperside. Aedeagus with two curved cornuti and one spine-like cornutus (fig. 26) 1. *T. austriaca*
- Larger species (2.8-3.5 mm), with 40-48 antennal segments. Androconial patch a darker yellow. Aedeagus without curved cornuti, but with one or two spine-like and a conical cornutus 6
- 6. Gnathos asymmetrical, with two large keels (fig. 51, 52). Aedeagus with two very similar spine-like cornuti 5. *T. victoris*
- Gnathos simple, symmetrical (figs. 30, 37). Aedeagus with three differently shaped larger cornuti 7
- 7. Very pale species: scale tips yellow (fig. 2). Valva almost triangular, gradually narrowing towards apex (fig. 33). Species from western France 2. *T. luteola*
- Darker species: scales with darker tips. Valva basally with almost parallel margins, distally suddenly tapering towards apex (fig. 38). Species from west Asia 3. *T. puplesia*

1. *Trifurcula austriaca* sp. n. (figs. 1, 8, 23-28, 29)

Trifurcula n. sp.; van Nieuwerken in Kasy 1985: 5.

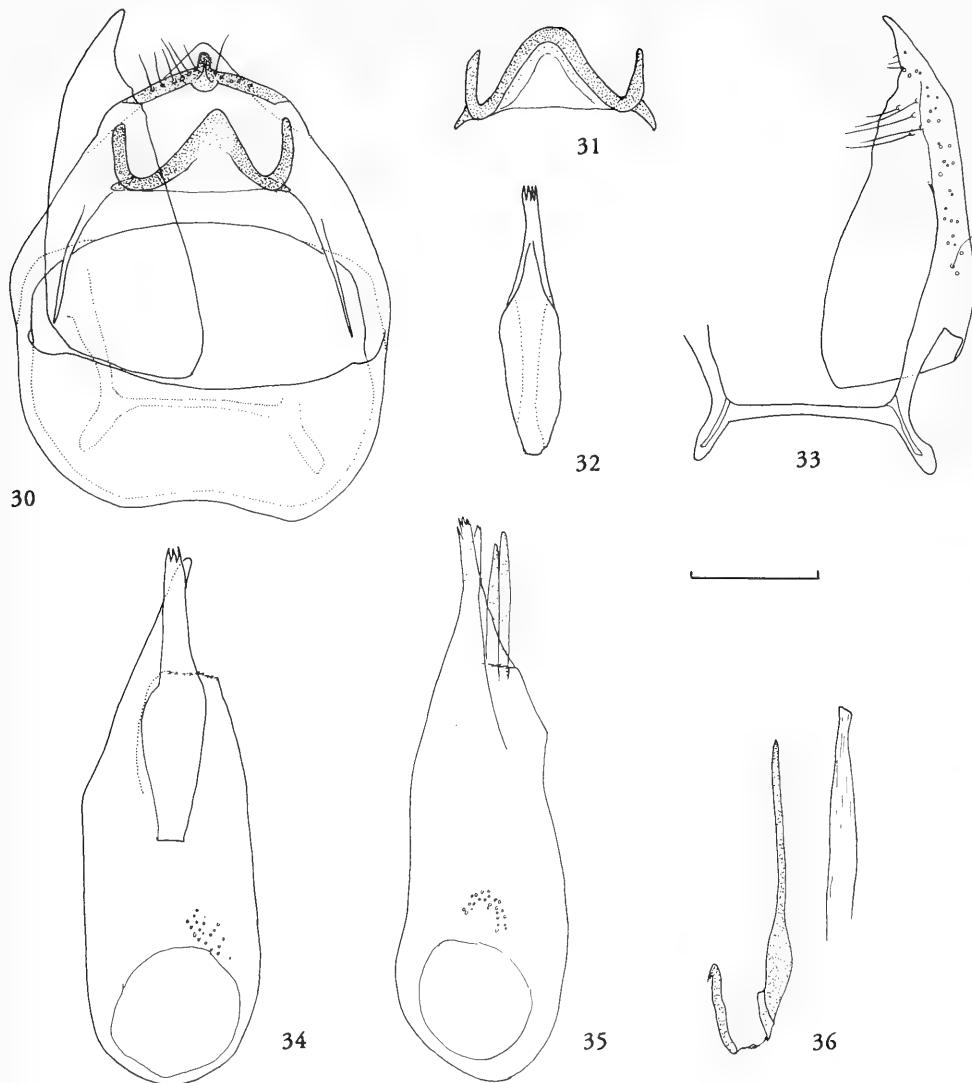
Type material. - Holotype ♂, Austria: Fürbachwiesen, E. of Gramatneusiedl (Niederöst.), UTM: 33U XP12, 15.v.1968, F. Kasy, Genitalia slide EvN 2591 (NHMW). - Paratypes, 2 ♂: same data, but 4.ix.1973, 31.vii.1978 (RMNH, NHMW).

Description

Male (fig. 1). - Forewing length 2.6-2.9 mm, wingspan 5.6-6.7 mm. Head: frontal tuft yellowish orange, collar yellowish white. Antenna with 34-37 segments; scape yellowish white, sometimes with a few dark scales. Forewing and thorax covered with fuscous tipped scales, mixed with white scales, giving a grey-brown impression; terminal cilia white beyond relatively distinct cilia-line. Underside of forewing with basal patch buff yellow, extending to $\frac{1}{4}$ (fig. 8). Hindwing with a row of white hair-scales instead of costal bristles; basally on upperside with some yellowish white to buff yellow scales, similar to forewing underside.

Female unknown.

Male genitalia (figs. 23-28). - Capsule length 330-350 μm . Vinculum anteriorly slightly narrowed, truncate; lateral arms near gnathos with minute spines. Uncus with medial process pointed, with pair of lateral setae. Gnathos symmetrical, central element triangular, with wide apical angle; anterior processes present. Valva length 245-255 μm , basally broad, with parallel margins, posterior half suddenly narrowed towards short pointed tip, transverse bar of transtilla less than twice the length of sublateral process. Aedeagus 310-385 μm .



Figs. 30-36. *Trifurcula luteola*, male genitalia. - 30, Capsule, valva outlined, slide 2342; 31, Gnathos, holotype, slide 2503; 32, juxta, holotype, slide 2303; 33, Valva, dorsal aspect, slide 2342; 34, Aedeagus, ventral aspect, holotype, slide 2303; 35, Aedeagus, ventro-lateral aspect, slide 2304; 36, Larger cornuti, holotype, slide 2303. Scale 0.1 mm.

long, with ventral carina posteriorly ending in two ventrally curved processes; dorsal lobe at right side indistinct, a large lobe at left side, ventrally enlarged and strongly sclerotized (fig. 27, 28). Vesica with three large cornuti (fig. 26): one long pointed (-135 μm) and two curved (respectively 85 and 60 μm); further a serrate cornutus lower in vesica, in addition to the group of needle-like and the small cornuti. Juxta fig. 24.

Diagnosis

Externally most similar to *subnitidella*, but without black scales near frenulum; *austriaca* also has special scales on hindwing upperside. Other species without black scales are larger and/ or paler (*luteola*, *puplesisi*, *victoris*). Male genitalia resemble more those of the *T. pallidella* group than other species in this group: the two curved cornuti and the triangular gnathos are diagnostic.

Biology

Immature stages and hostplant unknown. The adults were all taken at light, from May to September, in a grassland nature reserve, with a very rich Lepidoptera fauna (Kasy 1985).

Distribution (fig. 29)

Eastern Austria; only from the type locality: the 'Pischeldorf Fishawiesen' (named Fürbachwiesen on labels). After finishing this description, Z. Laštúvka showed me in August 1990 a drawing of male genitalia undoubtedly belonging to this species, from a specimen from Czechoslovakia: Prostějov Hamry [UTM: 33U XQ48], collected in 1990; this record is added on fig. 29. Possibly a species with an eastern distribution, like several other Lepidoptera species occurring in this area.

Etymology

An latinized adjective, from the type locality Austria.

2. *Trifurcula luteola* sp. n.

(figs. 2, 29, 30-36)

[*Trifurcula pallidella* Duponchel partim; Lhomme [1963]: 1209. Misidentification.]

Type material. – Holotype ♂: France, Molières[-sur-l'Alberte] (Aude), UTM: 31T DH57, 6.viii.1903, Chrétien, Genitalia slide EvN 2303 (MNHN). – Paratypes: 4 ♂. France: 1 ♂ (abdomen missing), data as holotype (MNHN); 1 ♂, Arten, [St. Pons, montagne d'Artenac] (Hérault), UTM: 31T DJ81, 19.vii.1904, Chrétien (MNHN); 2 ♂, Nespl. [Nespouls, near St. Pons] (Hérault), UTM: 31T DJ81, 2.viii.1904, (MNHN, RMNH).

Description

Male (fig. 2). – Forewing length (2.4) 3.2-3.4 mm, wingspan (5.4) 7.2-7.6 mm. Head: frontal tuft yellowish orange, collar paler. Antenna with 40-45 segments; scape white with few yellow scales. Forewing and thorax pale yellowish white, tips of scales yellow; terminal cilia concolorous. Underside of forewing with orange yellow basal patch to $\frac{1}{3}$, costal fold with row of brown scales along edge. Hindwing white, humeral lobe on upperside near frenulum with a row of yellowish-orange special scales.

Female unknown.

Male genitalia (figs. 30-36). – Capsule length 370-375 μm . Vinculum anteriorly truncate, broad and short. Uncus with medial process terminally truncate, not widened, several lateral setae. Gnathos symmetrical, central element approximately triangular, slightly angular or more rounded (figs. 30, 31); long anterior apodemes present, but not very distinct. Valva length 280-305 μm , roughly triangular, with short pointed tip; transverse bar of transtilla 2.5-3 \times as long as sublateral process. Ae-

deagus 405-435 μm long, with long, terminally fringed, ventral carina; vesica with one long, pointed cornutus (225-250 μm), a short conical (75 μm), \pm 10 long needle-like and many small cornuti. Aedeagal tube with dorsal lobe at right side not very pronounced, slightly serrate. Juxta fig. 32.

Diagnosis

Externally easy to separate from most other species by pale colour and size. Resembles *Trifurcula pallidella* (Duponchel), but male easily distinguished by yellow patch on forewing underside. Male genitalia characterized by triangular valva and triangular, symmetrical gnathos, but see *puplesisi*.

Biology

Immature stages and hostplant unknown. Adults collected in July and August.

Distribution (fig. 29)

Only known from Southwest France, in mediterranean region.

Remarks

The four specimens of this species were found amongst material labelled as *Trifurcula pallidella* in the Chrétien collection. Although the species has only been collected in the beginning of this century, it is very well possible that it still can be found, but has until now been overlooked, as was the case with *silviae*.

Etymology

A Latin adjective, from *luteolus* = yellow, orange, named after the pale forewing colour.

3. *Trifurcula puplesia* sp. n.

(figs. 37-44, 89, 95)

Type material. – Holotype ♂: Soviet Union: Turkmenistan, Sandykachi (Sandy Katschi), UTM: 41S MA55, 1.v.1986, Puplesis, Genitalia slide EvN 2760 (ZKVV). – Paratypes: 2 ♂, 4 ♀. Soviet Union: 1 ♂, 2 ♀, same data as holotype; 2 ♀, Turkmenia, Central Karakum, env. Ashkhabad, UTM: 40S FH20, 4.vi.1988, R. Puplesis (ZKVV, RMNH); 1 ♂, [Derbent (Dagestan), UTM: 39T TG76], 10.vii.[1872], ['Nach bei Lig'], Christoph, '473', Zeller Coll., Walsingham collection (BMNH).

Excluded from type-series (probably conspecific): 1 ♂, Krasnoarmeysk (Sarepta), UTM: 38U MX77, Christoph, '397' [red label] (BMNH).

Description

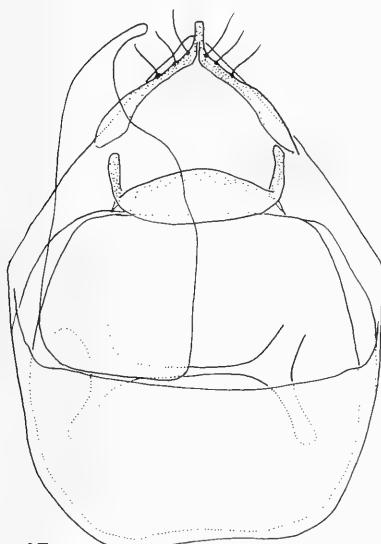
Male. – Forewing length 2.9-3.7 mm, wingspan 6.2-8.0 mm. Head: frontal tuft pale wish orange to almost white, collar white. Antenna with 46-48 segments; scape white. Forewing and thorax greyish brown, scales with dark tips, except along dorsum; terminal cilia white. Underside of forewing with a small pale yellow basal patch to $\frac{1}{5}$.

Hindwing white, humeral lobe on upperside near frenulum with some yellow special scales, similar to those on forewing underside; costa basally with row of white hair-scales.

Female. – Forewing length 3.2-3.3 mm (3.25 ± 0.04 , 4), wingspan ca 7.3 mm. Antenna with 43-45 segments.

Male genitalia (figs. 37-43). – Capsule length 350-410 μm . Vinculum wide and short, anteriorly broadly rounded. Uncus with medial process terminally truncate or bifurcate (figs. 37, 39). Gnathos symmetrical, central element broadly rounded, an-

terior apodemes not evident. Valva length 275-295 μm , broad, margins in basal half approximately parallel sided, tip slightly curved, pointed; transverse bar of transtilla approximately twice as long as sublateral process. Aedeagus 350-435 μm long, with long, terminally fringed, ventral carina and a dorsal lobe at right side, with serrate margin. Vesica with one long, curved, pointed cornutus (155-190 μm), a short conical (65-100 μm), a long irregular cornutus, seeming composed of several cornuti and almost hidden amongst the long needle-like cornuti; many small cornuti present. Juxta fig. 40.



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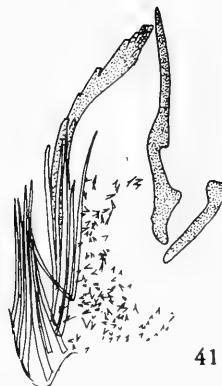
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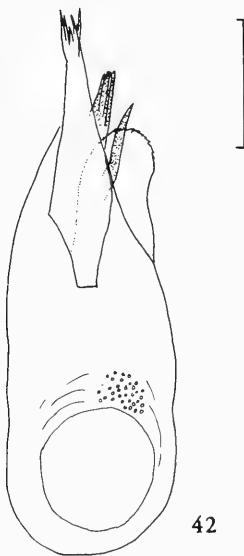
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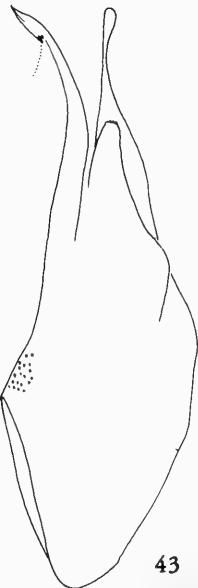
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Figs. 37-43. *Trifurcula puplesisi*, male genitalia. – 37, Capsule, valva outlined, slide 2761; 38, Valva, dorsal aspect, slide 2761; 39, Slightly different uncus of holotype, slide 2760; 40, Juxta, slide 2761; 41, Cornuti, dorsal aspect, slightly squashed, slide BM 25634; 42, Aedeagus, ventral aspect, part of cornuti, protruding from aedeagal tube also shown, slide 2761; 43, Aedeagus, lateral aspect, holotype, slide 2760. Scale 0.1 mm.



Fig. 44. Distribution of *Trifurcula puplesiai*, mapped on 50 × 50 km UTM squares.

Female genitalia (figs. 89, 95). – Terminal segments relatively broad; T8 with about 9–11 setae and several spines, broad anal papillae with 28–37 setae. Signa long, 525–630 µm. Ductus spermathecae with 3½ coils.

Diagnosis

Males resemble other species without black scaling and simple yellow patch, in particular *austriaca*, which is smaller and has fewer antennal segments and *luteola*, which is usually much paler and has a more triangular valva. Female recognized by large number of setae on anal papillae and relatively long signa.

Biology

Hostplant and immature stages unknown. The adults were taken in steppe area, almost desert, in May, June and July.

Distribution (fig. 44)

Caspian Sea area, just inside Europe and southern Turkmenia.

Remarks

The specimen from the Christoph collection, labelled 'Sarepta' is tentatively assigned to this species, but excluded from the type series, since it is much paler and shows slight differences in genitalia, such as the form of the juxta.

The paratype from the Zeller/Walsingham collection, also collected by Christoph, has only been labelled with: '10/7' [black ink on green, handwriting] / '473' [round label, black ink on green, handwriting] / 'Christoph' [black ink on white, handwriting], and the usual Walsingham collection labels with no. 101450. The locality has been traced from correspondence from Christoph to Zeller, now present in the Entomology Library, BMNH. Only in one letter with lists of specimens, sent by Chris-

toph to Zeller for identification, a number as high as '473' could be found. It is assumed that this refers to the specimen in question. The letter is dated 'Sarepta Den 12 März 1873' and bears the number 382. Under the number '473' in the list 'Determinanda' is written 'Derbent, Nacht b Ligt'. It is also assumed that the specimen was collected in July 1872, since the letter apparently refers to the most recent sending, collected in the previous year. Note further that the locality Derbent, a town on the Caspian Sea, is sometimes confused in lepidopteran literature with the locality 'Derbend' in Iran, North of Teheran, where recently various lepidopterists collected. Christoph often travelled via Derbent, when he crossed the Caspian Sea towards Turkmenistan or northern Iran (Christoph 1877), and as far as I know never collected in the Iranian 'Derbend'.

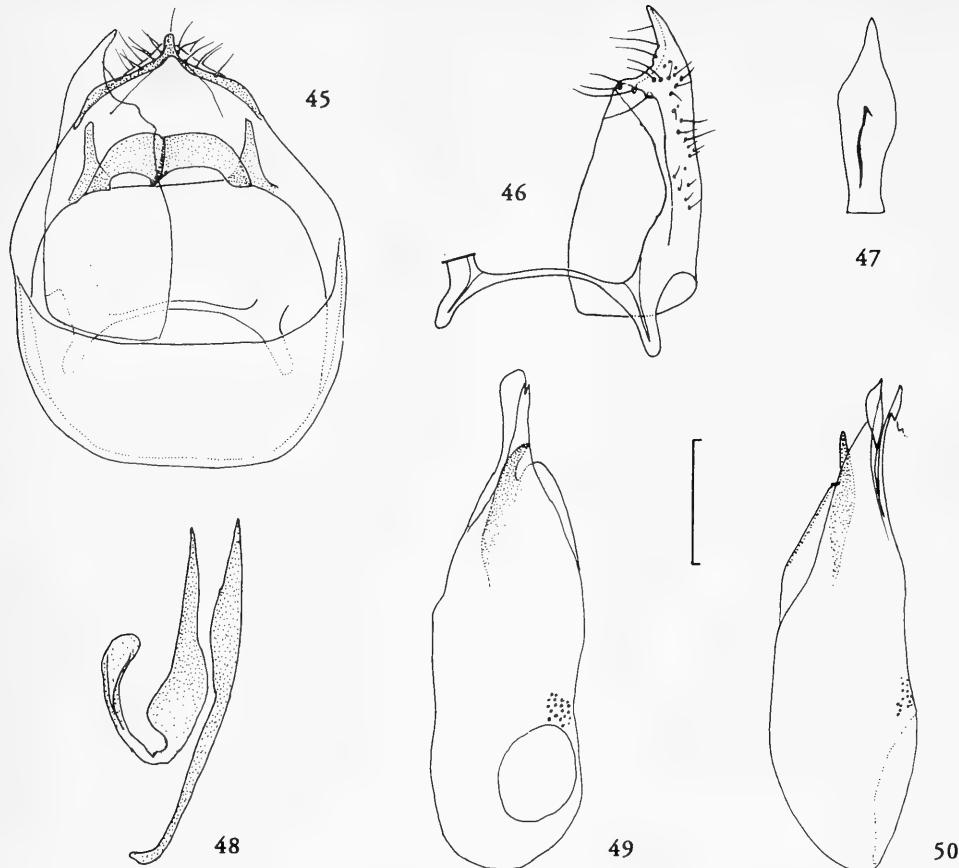
Etymology

A noun in genitive, named in honour of its collector, Dr. Rimantas Puplesis, a Lithuanian specialist of central and east Asian Nepticulidae, who kindly trusted me his material for description.

4. *Trifurcula coronillae* sp. n.

(figs. 3, 10, 18, 19, 29, 45–50, 90, 96, 101, 106)

Type material. – Holotype ♂: Spain, Sierra Blanca, 6 km N Marbella, El Mirador (Málaga), 800 m, UTM: 30S UF34, 5–9.ii.1984, *Coronilla juncea*, from stem-mines, e.l. 13.vii.1984, EvN no. 84046, E. J. van Nieuwerken, Genitalia slide EvN 2592 (RMNH). – Paratypes: 15 ♂, 11 ♀, 30 larvae. Spain: 4 ♂, 4 ♀, 7 larvae, data as holotype, e.l. 31.v.1984–25.viii.1984, (RMNH); 13 larvae, 5 km S Istán, road to Embalse de la Concepción (Málaga), 150 m, UTM: 30S UF2545, 17.i.1988, *Coronilla juncea*, stem-mines, EvN no. 88057, van Nieuwerken & Richter (RMNH); 4 ♂, El Saler (Valencia), UTM: 30S YJ26, 22.iv.1981, C. Gielis (RMNH, coll. Gielis); 2 larvae, Rodalquilar, 5 km SW Las Negras (Sierra del Cabo de Gata) (Almería), 120 m, UTM: 30S WF8579, 8.i.1988, *Coronilla juncea*, stem-



Figs. 45-50. *Trifurcula coronillae*, male genitalia holotype, slide 2592 (except 48, 49). – 45, Capsule, valva outlined; 46, Valva, dorsal aspect; 47, Juxta; 48, Large cornuti, separately drawn, slide 2593; 49, Aedeagus, ventral aspect, slide 1883; 50, Aedeagus, lateral aspect. Scale 0.1 mm.

mines, EvN no. 88005, van Nieuwerken & Richter (RMNH); 2 ♂, 4 ♀, Sierra Blanca, El Garopala, 3 km NNW Ojén (Málaga), 670 m, UTM: 30S UF3250, 15.i.1988, *Coronilla juncea*, stem-mines, e.l. 6.vi.1988-22.vii.1988, EvN no. 88051, van Nieuwerken & Richter (RMNH); 4 ♂, 3 ♀, 8 larvae, Sierra Blanca, Puerto de Marbella (El Mirador), 3 km W Ojén (Málaga), 900 m, UTM: 30S UF3048, *Coronilla juncea*, 15.i.1988, e.l. 30.v.1988-30.vii.1988, EvN no. 88047, van Nieuwerken & Richter (RMNH); 1 ♂, road to Istan (Málaga), 400 m, UTM: 30S UF24, 25.vi.1975, E. Traugott-Olsen (ZMUC).

Excluded from type series: 2 ♂ (abdomina lost), data as holotype, e.l. 1.viii.1984 (RMNH).

Description

Male (fig. 3). – Forewing length 2.6-3.2 mm (2.88 ± 0.17, 18), wingspan 5.6-6.7 mm. Head: frontal tuft yellowish orange to orange, collar slightly paler to almost white. Antenna with 41-48 segments (44.0 ± 2.0, 12); scape white, often with scattered

brown scales. Forewing and thorax covered with brown tipped scales, distal 1/4 dark, edge darker, giving the wing a greyish brown impression; white scales sometimes exposed at dorsum; terminal cilia yellowish white, cilia line indistinct. Underside of forewing with large patch, extending from base to 1/2, more or less distinctly divided into three areas with different colour: basally deep yellow, middle part buff yellow, terminally olive brown (figs. 10, 18, 19). Hindwing greyish, basal area with white lamellar scales.

Female. – Forewing length 2.4-3.2 mm (2.91 ± 0.23, 11), wingspan 5.4-6.4 mm. Antenna with 35-42 segments (39.8 ± 2.2, 10).

Male genitalia (figs. 45-50) – Capsule length 340-355 µm. Vinculum anteriorly truncate. Uncus with medial process truncate. Gnathos asymmetrical, with a longitudinal keel, slightly left of middle on

ventral surface, posterior margin rounded. Valva length 250-270 μm , with almost parallel margins, suddenly narrowed in terminal quarter towards pointed tip, transverse bar of transtilla twice as long as sublateral processes or longer. Aedeagus 360-390 μm long, with ventral carina bifurcate; aedeagal tube with spatulate tip ventrally, dorsal lobe not pronounced at right side, but with strong medial spine-like process, curved towards right side, which in normal preparations is almost inseparable from the large cornuti; there appear to be three in stead of two. Vesica with two large spine-like cornuti (one somewhat irregular) and a conical cornutus; long needle-like and many smaller cornuti present. Juxta fig. 47.

Female genitalia (figs. 90, 96). Terminal segments broad and rounded; T8 with 6-8 setae and several scales; anal papillae with 24-30 setae. Ductus spermathecae with 3½ to 3½ coils. Signa 420-470 μm (ventral) and 460-520 μm (dorsal) long.

Final instar larva (fig. 101). Yellow, elongate. Headcapsule 325-355 μm long ($341 \pm 10.7, 5$), 1.06-1.13 ($1.09 \pm 0.02, 5$) \times as long as wide. Spinosity: prothorax ventrally with narrow band posteriorly, meso- and metathorax ventrally with a band along anterior margin and very few spines on calli. Abdominal segments 1-9 with sparse spinosity ventrally and laterally up to the spiracles, spines near anterior margins smaller; segment 10 with small group of spines anterior of setae.

Diagnosis

Male easily recognized by the androconial patch with three different colours and absence of black scaling on hindwing. Male genitalia unique by shape of gnathos and cornutus-like process on aedeagus. Female very similar to *josefklimeschi*, but separated by the blunt abdominal point, versus the slightly pointed condition in *josefklimeschi*. Females of *victoris* are paler, and have less antennal segments, females of *subnitidella* are darker and have also less antennal segments.

Biology

Hostplant. – *Coronilla juncea* L., a shrub up to 1 m, with rush-like stems, slightly resembling a broom.

Life history. – The egg is deposited on an internodium of the smooth rush-like stem of the host-plant, and is conspicuous. The larva makes a very conspicuous gallery mine in the green bark, in which the living larva can easily been seen (fig. 106). The mine often starts contorting, frequently encircling the stem; the larva often feeds downward first, but later changes feeding direction one or more times, the mine usually ends in upwards direction. The mine is filled with greenish brown frass. There are often numerous mines in a single stem. The brown cocoon is made in soil or on leaf

litter. Larvae have been collected in January and February, but many mines were already vacated in that period, so that larvae probably start mining in autumn. Adults emerged over a very long period, from May to August. The only adults taken in the field were collected in April and June. The species is most likely univoltine.

Distribution (fig. 29)

Along mediterranean coast of Spain, to be expected elsewhere with its host, which occurs from West Yugoslavia to Portugal (Heywood & Ball 1968).

Etymology

A noun in genitive case, from *Coronilla*, the generic name of the hostplant.

5. *Trifurcula (Trifurcula) victoris* sp. n.

(figs. 4, 51-56, 76, 91, 97, 102)

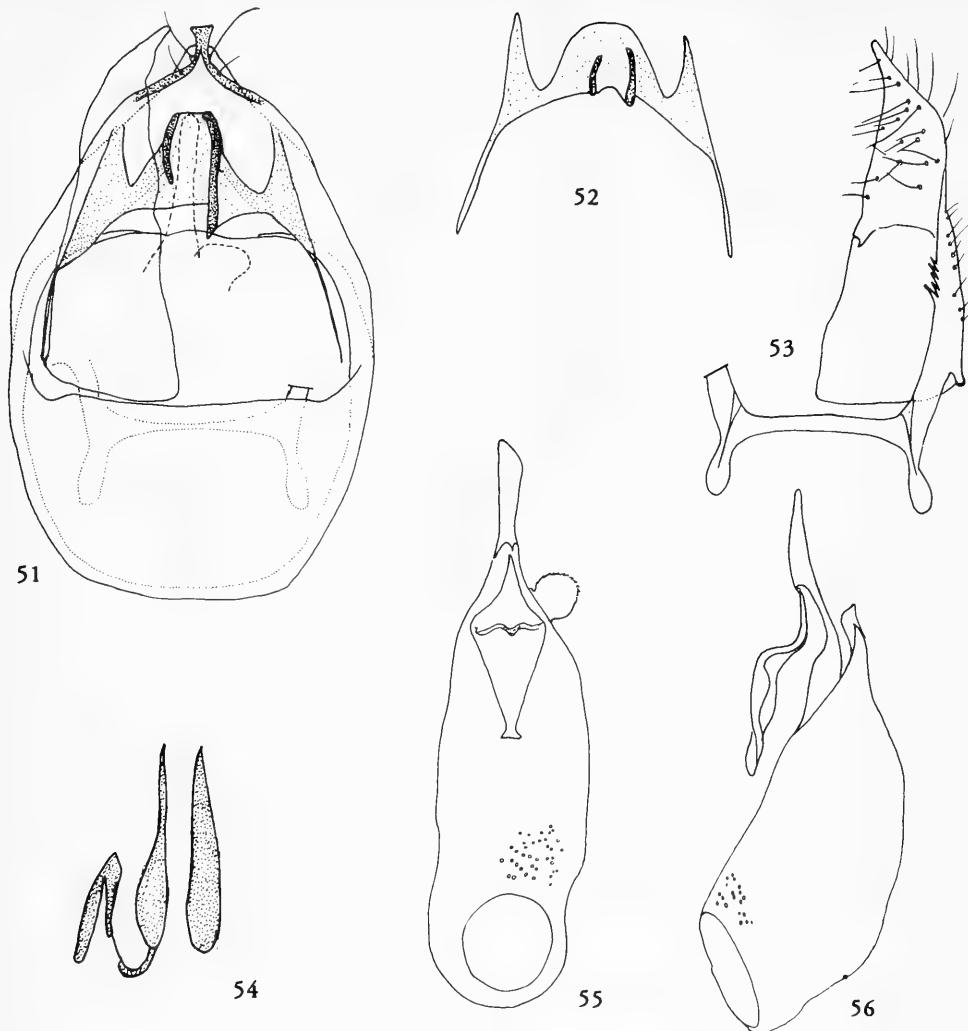
Type material. – Holotype ♂: Spain: El Pozo de los Frailes, 3 km N San José (Almería), UTM: 30S WF7972, 8.i.1988, *Anthyllis cytisoides*, stem-mines, e.l. 4.iii.1989; EvN no. 88003, van Nieuwerken & Richter (RMNH). – Paratypes: 2♂, 6♀, 4 larvae. Spain: 2♂, 6♀, 3 larvae, same data as holotype, e.l. 29.ii.1989-30.v.1989 (RMNH); 1 larva, 3 km NE Níjar, Cerro de Movillas (Almería), 400 m, UTM: 30S WF7393, 9.i.1988, *Anthyllis cytisoides*, stem-mines, EvN no. 88007, van Nieuwerken & Richter (RMNH).

Description

Male (fig. 4). – Forewing length 3.0-3.5 mm, wingspan 6.5-7.2 mm. Head: frontal tuft yellowish-orange to ferruginous, collar paler, yellowish white. Antenna with 40-42 segments; scape white, with some darker scales, flagellum brown. Forewing and thorax relatively pale, appearing pale brown-grey: scales with distalmost tip (margin only) brown, few white scales at tornus; terminal cilia white beyond more or less distinct cilia-line. Underside of forewing with deep yellow patch of about $\frac{1}{4}$ forewing length. Hindwing grey, humeral lobe well developed, on upperside with yellow scales along margin, black scaling absent.

Female. – Forewing length 2.9-3.3 mm ($3.04 \pm 0.12, 6$), wingspan 6.5-7 mm. Antenna with 32-35 segments ($33.5 \pm 1.3, 4$). Ovipositor with short point.

Male genitalia (figs. 51-56) – Capsule length 425-440 μm . Vinculum anteriorly truncate or rounded. Uncus with medial process strongly widened, truncate. Gnathos very asymmetrical, variable, always with two longitudinal keels of different length, leaving ventrally excavation in which aedeagal tip fits (dashed in fig. 51), anterior apodemes present. Valva length 285-290 μm , approximately triangular, dorsally with a row of 4-5 spines along continuation of lateral arm of transtilla, transverse bar



Figs. 51-56. *Trifurcula victoris*, male genitalia. – 51, Capsule, valva and tip of aedeagus outlined, slide 3064; 52, Gnathos of holotype, showing variation, slide 2743; 53, Valva, dorsal aspect, slide 3064; 54, Large cornuti, separately drawn, slide 3064; 55, Aedeagus and juxta, ventral aspect, slide 3064; 56, Aedeagus and juxta, lateral aspect, holotype, slide 2743. Scale 0.1 mm.

of transtilla about twice as long as sublateral processes. Aedeagus 395-435 μm long, with ventral carina spatulate, dorsal lobe at right side conspicuous, margin serrate; vesica with two large and very similar cornuti, one joined to smaller cone-shaped cornutus; group of spine-like cornuti very much reduced in size and number, only a few present at basis of both large cornuti; numerous small cornuti present. Juxta fig. 55.

Female genitalia (figs. 91, 97). – Terminal segments forming slightly pointed abdominal tip; T8

with 8-10 setae and some scales; anal papillae with 21-29 setae. Ductus spermathecae with 4 coils. Signa 465-530 μm long.

Final instar larva (fig. 102). – Yellow, elongate. Head capsule 385-435 μm , 1.03-1.05 \times as long as wide. Spinosity: prothorax ventrally with narrow band of minute spines posteriorly, meso- and metathorax ventrally without spines. Abdominal segments 2-9 with microspines ventrally, hardly visible; segment 10 with small group of spines anterior of setae.

Diagnosis

Male recognized by uniformly coloured yellow patch, absence of black scaling and relatively pale forewings. *T. luteola* is paler, with yellow scale tips instead of brown or grey. Male genitalia characterized by asymmetrical gnathos with two keels and reduction of spine-like cornuti. Female may be confused with *coronillae*, which is darker; *victoris* also has more pointed anal papillae.

Biology

Hostplant. – *Anthyllis cytisoides* L., a broom-like leafy shrub of 0.5-1.5 m, with velvety hairy stems and leaves.

Life-history. – Egg deposited on stem. The larva makes a long gallery in the bark, which is difficult to see, because of the dense indumentum of the stem. It could best be seen because of the swelling and the slight discoloration, especially in the case of old mines. Larva not visible in its mine. The mines were actually collected on stems, heavily infested by gall-forming coccids. Larvae collected in January, adults emerged from February to May. One female emerged from leaf-litter, which had been collected from underneath the hostplants.

Distribution (fig. 76)

Only known from the extremely dry region in the southeast part of the province of Almería, Spain. Despite search in other sites along the Spanish southcoast, where the host is common, no more mines could be found.

Etymology

A noun in genitive case, from latin *victor*, named after my son Victor Alexander.

6. *Trifurcula* (*Trifurcula*) *subnitidella*

(Duponchel)

(figs. 5, 9, 11-17, 57, 61-68, 92, 98, 103, 107)

Elachista subnitidella Duponchel, [1843]: 326, pl. 77: 8. Lectotype ♂ [designated by van Nieuwerken & Johansson 1987: 471]; [Austria, Vienna region], Duponchel coll., Genitalia slide EvN 2522 (MNHN) [examined].

Trifurcula griseella Wolff, 1957: 21. Holotype ♂: Denmark, Asserbo, 30.v.1954, N. Wolff, genitalia slide NW 1797 (ZMUC) [Synonymized by van Nieuwerken & Johansson 1987: 471] [examined].

Nepticula subnitidella (Duponchel) Zeller 1848: 305 [redescription, mistaken identity], Joannis 1915: 127 [identity], Rebel 1901: 221 [catalogue], Meess 1910: 474 [listed].

Trifurcula subnitidella (Duponchel) van Nieuwerken & Johansson 1987: 471 [selection lectotype], 1990: 273 [description, NW Europe].

Trifurcula griseella Wolff; Bradley 1962: 174, fig. 4 [Ireland, male genitalia], Bjørn & Pallesen 1971: 111 [Denmark], Bradley et al. 1972: 3 [Britain], Svensson 1974: 171 [Sweden], Emmet 1975: 39-42 [England, Scotland], Karsholt & Nielsen 1976: 18 [Denmark], Emmet 1976: 209 [description, British Isles], Svensson

1980: 85 [Sweden], Buhl et al. 1983: 120 [Denmark], Svensson 1983: 65 [Sweden], Kasy 1983: 5 [Austria], Buhl et al. 1984: 3 [Denmark], Svensson 1985: 81 [Sweden], Kasy 1985: 5 [Austria], Karsholt 1985: 45 [catalogue Denmark], van Nieuwerken 1986a: 16 [checklist], Bradley & Fletcher 1986: 2 [list], Pröse 1987: 49 [West Germany: Bavaria], Svensson 1987: 3-3 [catalogue Sweden], Buhl et al. 1987: 100 [Denmark], Buhl et al., 1988: 101 [Denmark].

Description

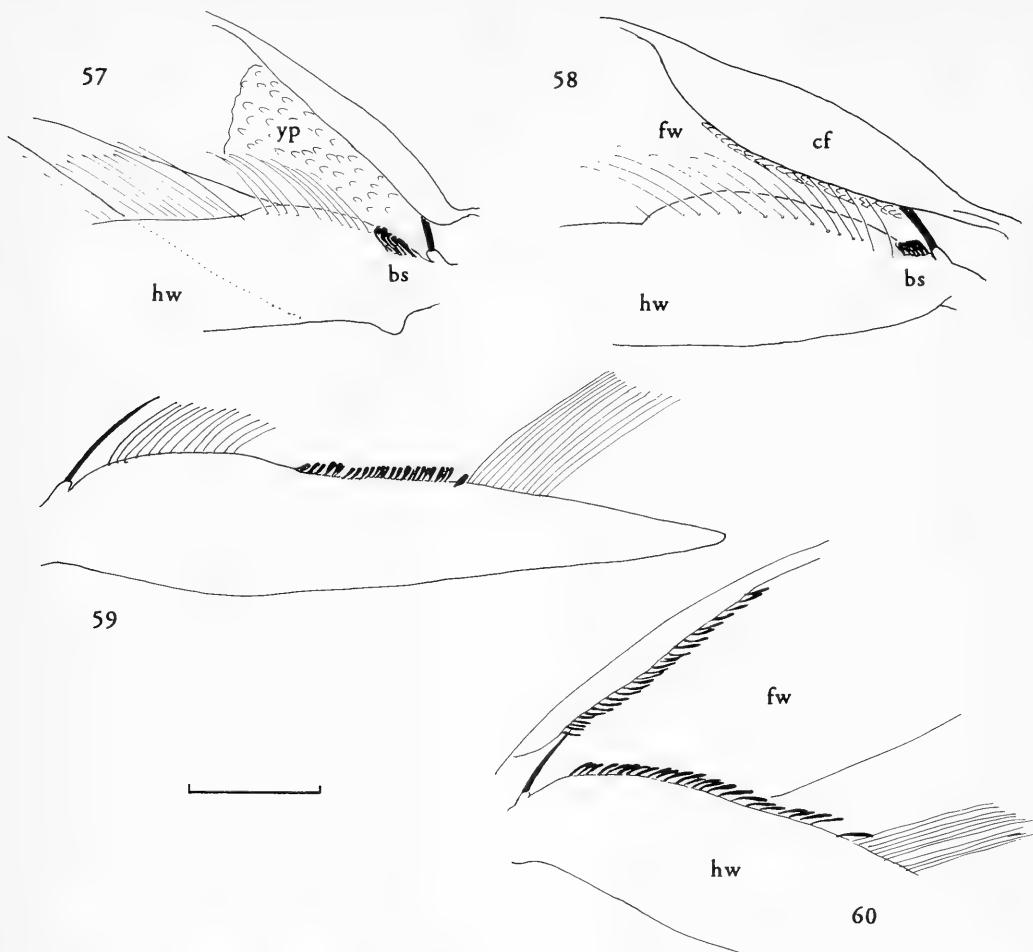
Male (fig. 5). – Forewing length 2.0-2.6 mm (2.37 ± 0.17, 44), wingspan 4.2-5.8 mm. Head: frontal tuft yellow-ochre to fuscous, variable; collar similar. Antenna with 31-36 segments (33.4 ± 1.3, 40); scape white, sometimes with few brown scales. Forewing dark greyish-brown to fuscous, slightly irrorated by dark tipped scales, no white spots present; underside with distinct basal patch of deep yellow scales near costa reaching to ¼ (figs. 9, 11-13). Hindwing: grey, underside along costa directly behind frenulum with a distinct short row of black lamellar scales (figs. 14, 15, 57). Abdomen dark grey, with yellowish grey tufts.

Female. – Forewing length 2.0-2.4 mm (2.22 ± 0.16, 9), wingspan 4.4-5.4 mm. Antenna with 27-32 segments (30.4 ± 1.7, 9).

Male genitalia (figs. 61-67). – Capsule length 330-390 µm (349.6 ± 14.8, 15). Vinculum anteriorly rounded. Uncus slightly widened, truncate at tip. Gnathos asymmetrical, central element with an anteriorly curved keel, ending in a pointed process at right side; lateral arms with long and narrow anterior apodemes. Valva length 250-289 µm (264.2 ± 9.0, 15), basally with almost parallel margins, narrowed in middle towards pointed tip. Aedeagus 330-365 µm (344.0 ± 14.0, 15), with ventral carina bifid, aedeagal tube with spatulate tip, dorsal lobe in middle, or slightly on right side, with serrate margin. Vesica with one very long straight, or slightly curved cornutus, with a conical cornutus joined to its basis, and a pointed cornutus with serrations; less than 10 spine-like cornuti and many small cornuti present. Juxta fig. 62.

Female genitalia (figs. 92, 98). – Terminal segments rather broad; T8 with 3-6 setae and some scales; anal papillae with 11-20 setae each. Ductus spermathecae with 3½ convolutions. Signa 300-355 µm (dorsal) and 350-365 µm (ventral) long.

Final instar larva (fig. 103). – Long and slender, deep yellow. Head capsule 325-345 µm, 1.13-1.16 × as long as wide, distinctly narrower than in other three described species. Spinosity: prothorax ventrally with narrow band posteriorly, meso- and metathorax with spines between D1 seta and calli. Abdominal segments 1-9 with sparse spinosity ventrally and laterally up to the spiracles, spines near anterior margins smaller; segment 10 with small group of spines anterior of setae.



Figs. 57-60. *Trifurcula* males, forewing and hindwing undersides, showing position of black scales, yellow patch and costal fold. - 57, *T. subnitidella*, Netherlands, Katwijk; 58, *T. josefklimeschi*, paratype, Austria, Hundsheimer Berg; 59, *T. iberica*, hindwing only, paratype, Spain, Prullans; 60, *T. silviae*, paratype, France, Ceillac. Scale 0.3 mm.

Diagnosis

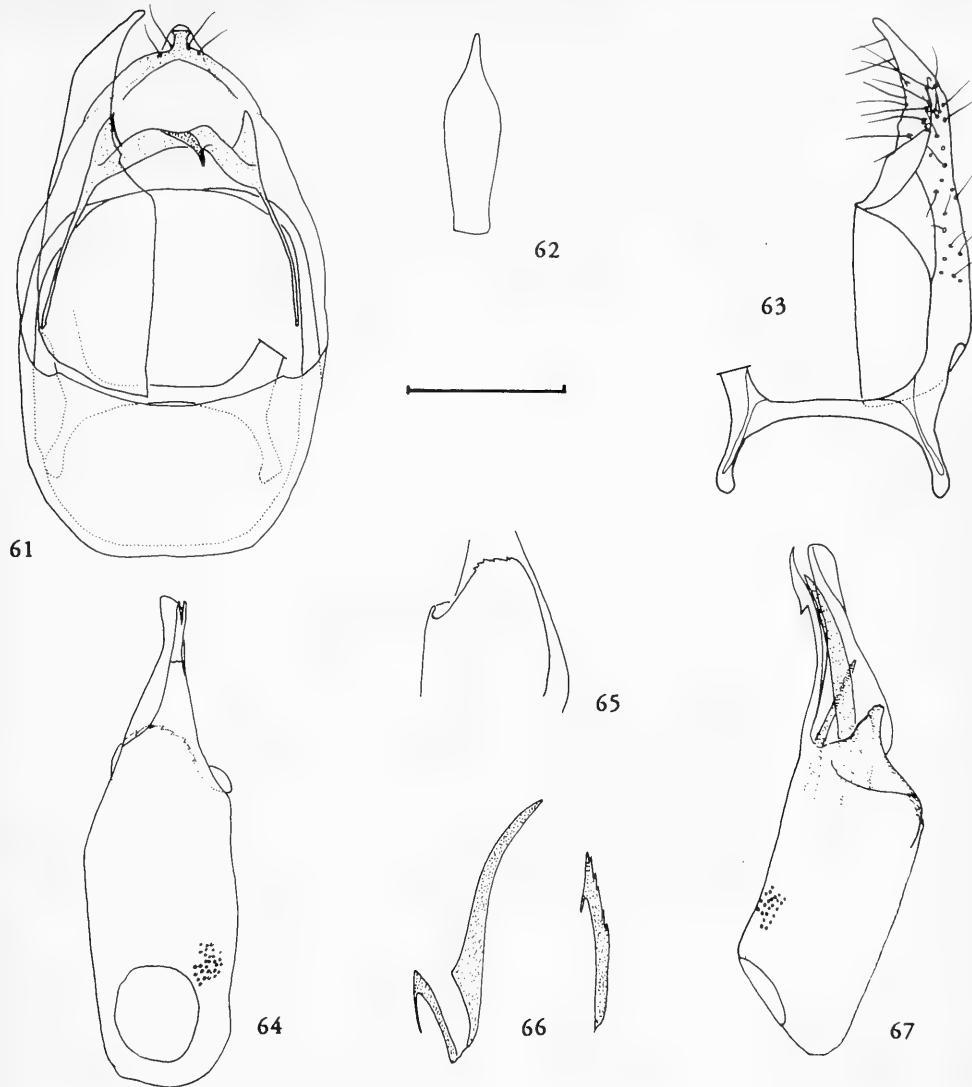
Male *subnitidella* differs from other species in the group by the combination of a simple yellow patch and a group of black scales just behind frenulum; further it is one of the smaller and darker species, with less antennal segments than most other species (36 maximum). The male genitalia are well characterized by the gnathos process. Females are smaller and darker than the other described females, and have less antennal segments.

Biology

Host plant. - *Lotus corniculatus* L., a common perennial herb of grasslands all over Europe, possibly also on other *Lotus* species.

Life history. - The egg is conspicuous and deposited on the stem of the host, usually at the base

of a leaf-stalk (fig. 107), frequently near the stem base. The mine is a long gallery in the bark of the stem (fig. 107): the larva is first mining down for 0.5-2 cm, then going up the stem in a rather straight line, or partly encircling the stem, occasionally going down again in the last part of the mine. The mine may reach a total length of 6 to 9 cm. The mine is at first narrow, reddish brown, with straight edges, but later becomes as wide as the stem, with irregular margins, becoming silvery white in fresh mines. Frass deposited in midline, brown, not always well visible. Larva well visible in mine, appearing as a slight swelling. The stems of the host are not killed by the mining activity. The larva quits the mine through a semicircular slit, and spins a cocoon in the soil or on leaf-litter.



Figs. 61-67, *Trifurcula subnitidella*, male genitalia, slide 2501 (slide 2745 for fig. 62). – 61, Capsule, valva outlined; 62, Juxta; 63, Valva, dorsal aspect; 64, Aedeagus, ventral aspect; 65, Idem, dorsal lobe, dorsal aspect; 66, Large cornuti, separately drawn; 67, Aedeagus, lateral aspect. Scale 0.1 mm.

Larvae have been taken in September and October, adults fly from May (March in Tunisia) to early September. Reared adults emerged in May. Voltinism not yet clear from these data, clear peaks in flight are not apparent. More data from single localities are needed, and bivoltinism can only be proved by finding larvae and rearing in early summer.

In northern Europe *T. subnitidella* is almost exclusively found on limestone grasslands (downland) and coastal dunes, in southern Europe it is found in many habitat types. The species might be vulnerable to habitat loss in more northern parts of its occurrence.

Distribution (fig. 68)

Widespread in Europe, northward to 60° N, southward to the northern border of the Sahara in Tunisia and eastward to the Crimea and Asia minor. Not yet recorded from Norway, Belgium, Luxembourg, Switzerland, Poland, Hungary, Albania and Portugal, nor from any of the large mediterranean islands. The species is here for the first time in detail recorded from Finland, The Netherlands, Germany, Czechoslovakia, France, Spain, Italy, Romania, Bulgaria, Yugoslavia, Greece, Turkey, Soviet Union (Estonia and Ukraine) and Tunisia.

Remarks

T. subnitidella is slightly variable in colour, specimens from northern Europe tend to be darker than those from southern Europe.

The figure of the male genitalia in Wolff's description of *T. griseella* (1957), has been published as mirror image.

In North America, a striking case of convergence has been described by Wagner (1987): his species *Microcalyptis lotella* was reared from very similar stem-mines in *Lotus*, and, moreover as adult male it has a yellowish patch on the forewing underside, very similar to that of *subnitidella*. Also *lotella* has been found in a habitat that in Europe could harbour *subnitidella*: coastal dunes. Yet *Microcalyptis* Braun (synonymized with *Acalyptis* Meyrick by van Nieuwerken 1986a) is a completely different genus, only distantly related to *Trifurcula*.

Material examined. – 115 ♂, 14 ♀, 5 larvae (including type-material cited above). – Austria: 1 ♂ [genitalia slide MV13111 only], Aperflon, Seewinkel (Burgenland), UTM: 33T XN38, 9.viii.1963, F. Kasy (NHMW); 1 ♂, Fürbachwiesen, East of Gramatneusiedl (Niederöst.), UTM: 33U XP11, 23.vii.1981, F. Kasy (NHMW); 1 ♂, Hundsheimer Berg S. (Niederöst.), UTM: 33U XP43, 8.vii.1980, F. Kasy (NHMW); 1 ♂ [photo genitalia slide], Linz, surroundings (Oberöst.), UTM: 33U VP44, 18.vii.1934, J. Klimesch (coll. Klimesch). – Bulgaria: 1 ♂, Nesebur (Nessebar), UTM: 35T NH52, 23.viii.-4.ix.1962, J. Soffner (DEIC). – Czechoslovakia: 2 ♂, Detkovice (Moravia), UTM: 33U XQ57, 2.vi. and 4.vii.1989, A. Laštůvka (coll. Laštůvka). – Denmark: 1 ♀, Asserbo, UTM: 33V UC11, 10.vi.1964, N. L. Wolff (ZMUC); 6 ♂ Laesö, Bovet (NEJ), UTM: 33V PJ25, 8, 9 and 13.vii.1982, 30.vi and 8.vii.1983, O. Karsholt (ZMUC); 9 ♂, 5 ♀, Laesö, Höjsandet (NEJ), UTM: 33V PJ25, 1 and 6.vii.1983 O. Karsholt (ZMUC); 4 ♂, Laesö, Nordmarken (NEJ), UTM: 33V PJ25, 5, 6 and 9.vii.1983, O. Karsholt (ZMUC). – Finland: 2 ♂, Virolahti (EK), UTM: 35V NH30, 27.vi.1989 [netted at seashore over *Lotus corniculatus*], J. R. Kaitila (RMNH). – France: 1 ♂, Cannes (Alp. Mar.), UTM: 32T LP42, iv.1881, Walsingham (BMNH); 1 ♂, Col de Soubeyrand (Drôme), 994 m, UTM: 31T FK81, 2.viii.1986, H. W. van der Wolf (coll. van der Wolf); 1 ♂, La Veuve, Digne, UTM: 32T KP78, 12.viii.1901, Chrétien (MNHN); 1 ♂, Nespl. [probably Nespouls, near St. Pons] (Hérault), UTM: 31T DJ81, 2.viii.1904, (MNHN). – Germany (West): 2 ♂, Bamberg: Tütschengereuth (Bayern), UTM: 32U PA22, 4.viii.1978, G. Derra (coll. Derra). – Germany (East): 2 ♂, Blankenburg, Muschelkalk, UTM: 32U PB51, 29.v.1965, 10.viii.1989, H. Steuer (coll. Steuer). – Great Britain: 1 ♂, Mickleham (Surrey), UTM: 30U XB88, 23.vi.1856, grass, H. T. Stanton (BMNH); 1 ♂, Mickleham, Headley Lane (Surrey), UTM: 30U XB88, 10.vi.1857, (BMNH). – Greece: 1 ♂, Kavisos (Evro), 100 m, UTM: 35T MF, 22-23.vii.1985, A. Moberg (NHRS). – Italy: 2 ♂, Almese, surroundings (Torino), 350 m, UTM: 32T LQ79, 16 and 20.v.1979, U. Parenti (RMNH, coll. Parenti); 1 ♂, Asti, Boschi di Valmanera, 124 m, UTM: 32T MQ37, 1.v.1970, G. Baldizzone (GBA); 2 ♂, Asti, Valmanera (Asti), UTM: 32T MQ37, 28.iv.1968, 26.viii.1968, G. Baldizzone (RMNH, coll. Passerin-d'Entrèves); 1 ♂, Baia Domizia (Caserte), UTM: 33T UF55+, 25.vii.1972, R. Johansson (coll. Johansson); 1 ♂, Cardona (Alessandria), 300 m,

UTM: 32T MQ39, 19.v.1975, G. Baldizzone (GBA); 2 ♂, Lucotena (Firenze), 500 m, UTM: 32T PP93, 11.viii.1982, J. Kuchlein (RMNH, coll. Kuchlein); 1 ♂, Monti Aurunci, 5 km N Itri (Latina), 600 m, UTM: 33T UF77, 24-30.v.1969, R. Johansson (coll. Johansson); 1 ♂, Poggio di Casasco (Alessandria), 300 m, UTM: 32T NQ06, 3.vi.1978, G. Baldizzone (GBA); 2 ♂, Val Susa (Piemonte), Villardora (Torino), 500 m, UTM: 32T LQ79, 26.v.1983, G. Bassi (coll. Bassi). – Netherlands: 1 ♂, Katwijk, 2 km N: dunes (Zuid-Holland), UTM: 31U ET9686, 16.x.1988, *Lotus corniculatus*, stem-mines, e.l. 21.v.1989, EvN no. 88175, van Nieuwerken & Richter (RMNH); 1 ♂, Kunrade, Kunderberg (Limburg), UTM: 31U GS0739, 02.vii.1983, G. R. Langohr (coll. Langohr); 2 ♂, 2 ♀, 3 larvae, Kunrade: Kunderberg W. (Limburg), UTM: 31U GS0739, 5.x.1988, *Lotus corniculatus*, stem-mines, e.l. 10.v.1989-18.v.1989, EvN no. 88156, van Nieuwerken & Richter (RMNH); 1 ♂, St. Pietersberg, Cannerbos (Limburg), UTM: 31U FS8733, 18.-19.vi.1950, [22.3-0.3 hrs] (RMNH); 1 ♂, St. Pietersberg, Zonneberg (Limburg), UTM: 31U FS8934, 20.vii.1950, [21-22 hrs] (RMNH); 1 ♂, 1 ♀, 2 larvae, Wijlre, 1 km SE: railway banks (Limburg), UTM: 31U GS0534, 5.x.1988, *Lotus corniculatus*, stem-mines, e.l. 11.v.1989-15.v.1989, EvN no. 88162, van Nieuwerken & Richter (RMNH); 1 ♂, 1 ♀, Vrakelberg, 2 km E. of Wijlre, UTM: 31U GS0537, 22.ix.1989, *Lotus corniculatus*, stem-mines, e.l. 1-5.v.1990, E. J. van Nieuwerken (RMNH); mines, Noord-Bakkum, 3 km N Castricum (Noord-Holland), dune meadows, UTM: 31U FU1226, 6.x.1989, *Lotus corniculatus*, E. J. van Nieuwerken. – Rumania: 1 ♂, Gusterita near Sibiu (Hammersdorf near Hermannstadt), UTM: 35T KL87, 12.v.1920, (NHMW); 1 ♂, Sibiu (Hermannstadt, Pralb.), UTM: 35T KL87, 18.v.1922 (NHMW). – Spain: 1 ♂, Beuda (Pyr. orient.), UTM: 31T DG77, 14.vii.1967, E. Arenberger (LNKD); 1 ♂, Biescas (Huesca), UTM: 30T YN12, 1.viii.1989, C. Gielis (coll. Gielis); 3 ♂, Puerto de Mora (Granada), 1350 m, UTM: 30S VG52, 22.vii.1986, C. Gielis (RMNH, coll. Gielis); 1 ♂, San Miguel de Valero N, 3 km S Linares de Riofrio (Salamanca), 850 m, UTM: 30T TK59, 2.viii.1986, at light ML, Quercus pyrenaica forest & heathland, EvN no. 86091, E. J. v. Nieuwerken & S. Richter (RMNH); 1 ♂, Sierra de Marbella, El Mirandor (Málaga), 700 m, UTM: 30S UF34, 21.vii.1981, E. Traugott-Olsen (ETO); 1 ♂, road Baza-Benamaurel, 15 km from Baza (Granada), UTM: 30S WG25, 16.vii.1987, Baldizzone & Traugott-Olsen (GBA); 1 ♂, road to (Camino de) Ojen (Málaga), 150 m, UTM: 30S UF34, 25.vi.1983, E. Traugott-Olsen (ETO). – Sweden: 2 ♂, 1 ♀, Byrum Sandvik (Öland), UTM: 33V XD1742, 20.vi.1978, B. Bengtsson (coll. Johansson, ZMUC); 1 ♀ [slide only], Kinnekulle (Vg), UTM: 33V VE09, 29-30.v.1968, I. Svensson (coll. Svensson); 1 ♂, Klagshamn (Sk), UTM: 33V UB65, 7.viii.1982, R. Johansson (coll. Johansson). – Soviet Union: 1 ♂, Dobroe, Krasnolesje [near Simferopol] (Krim, Ukraine), UTM: 36T XQ06, 10.v.1982, Zaguljaev (ZMAS); 1 ♂, Rakvere (Raastfer) [near Tallinn] (Estonia), UTM: 35V MF68, 8.vi.1890 (ZMAS); 1 ♂, Sevastopol, Inkerman (Krim, Ukraine), UTM: 36T WQ44, V. Pliginiski (ZMAS). – Tunisia: 1 ♂, Nefta, UTM: 32S LC94, 14-16.iii.1986, Zool. Mus. Copenh. (ZMUC). – Turkey: 2 ♂, Ankara, 10 km NW Kizilcahaman, 1150-1250 m, UTM: 36T VK68, 6-7.viii.1989, Fibiger & Esser (ZMUC). – Yugoslavia: 1 ♂, Herceg Novi, Igalo, UTM: 34T BN90, 1.v.1938, H. G. Amsel (LNKD); 16 ♂, Krk, Draga Baska (Kroatia), UTM: 33T VK78, 25 and 27.vii.1976, 3.viii.1976, 1.viii.1977, 3.viii.1978, 5.viii.1985, 30.vii.1986, 15.viii.1988, G. Baldizzone (GBA, RMNH); 6

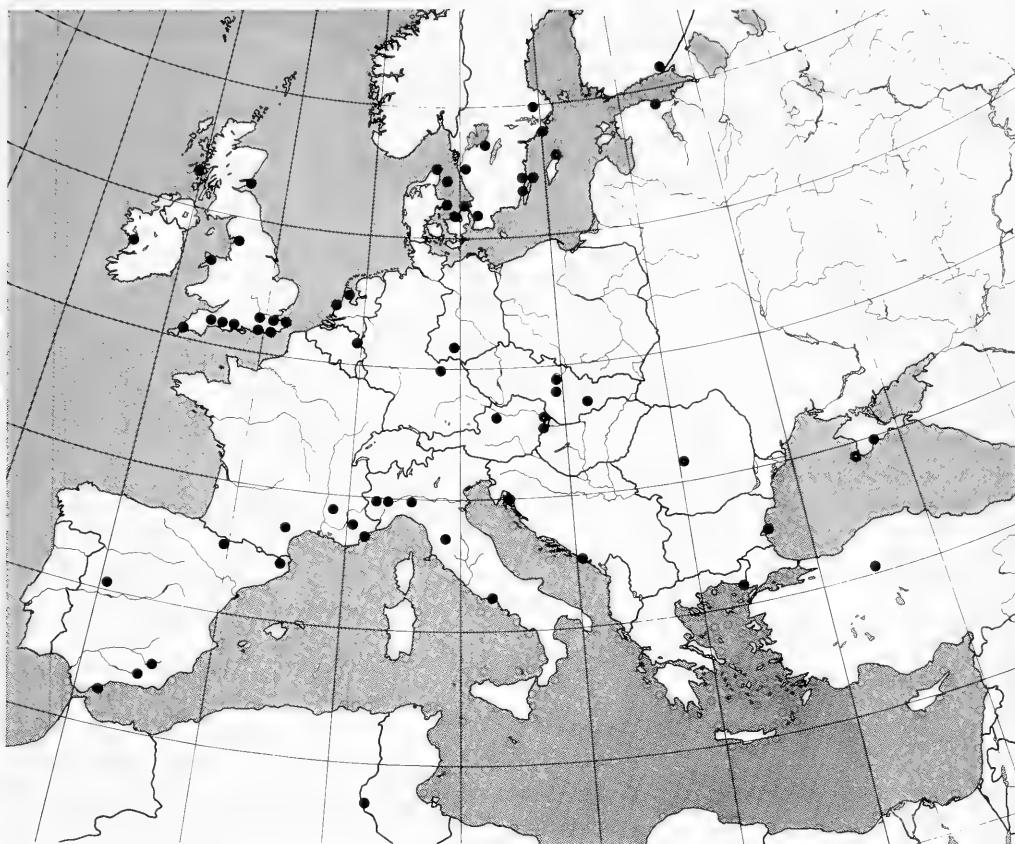


Fig. 68. Distribution of *Trifurcula subnitidella*, mapped on 50 × 50 km UTM squares.

♂, 2 ♀, Krk, Misucaynica (Kroatia), UTM: 33T VK78, 18.viii.1973, 30.vii.1976, 6.viii.1976, 4 and 9.viii.1986, G. Baldizzone (GBA, RMNH); 1 ♂, Krk, Paprata/Vinder (Kroatia), UTM: 33T VK79, 16.viii.1978, G. Baldizzone (GBA); 1 ♂, Krk, Soline (Kroatia), UTM: 33T VK69, 11.viii.1976, G. Baldizzone (GBA); 8 ♂, Krk, road Krk-Vrbnik (Kroatia), UTM: 33T VK78, 2.viii.1987, 23.vii.1988, 3.viii.1988, G. Baldizzone (GBA, RMNH).

Additional records. – Czechoslovakia: Čelechovice (UTM: 33U XQ78), Prostějov Hamry (33U XQ48), Kožárovce (34U CU15) (Z. Laštúvka in litt.). – Denmark: Melby Overdrev (Buhl et al. 1983), Korevle (Buhl et al. 1984), Glatved (32V PH14) (Buhl et al. 1987a), Øster Vrå (32V NJ75) (Buhl et al. 1988). – Great Britain: vice counties 1, 3, 9, 10, 13, 14, 15, 16, 17, 49, 69, 85 and 103 (Emmet in litt. 1987). – Sweden: Hall, Vallda Sandö (PJ7674), Sm. Rynningsnäs (WD5647), Öl. Algutstrum (WC9284), Gtl. Tingstäde (CK5802), Sdm. Ösmo (XF6739), Upl. Fysingen (XG6407) (Svensson in litt. 1987).

7. *Trifurcula josefklimeschii* sp. n.

(figs. 6, 20-22, 58, 69-76, 93, 99, 104, 105)

[*Trifurcula orientella* Klimesch, 1953: 168, 169 partim: all specimens from Austria. Misidentification.]
Trifurcula nov. spec., van Nieuwerken in Kasy 1983: 5.

Type material. – Holotype ♂: Italy, M. Bondia, Villa Faraldi, 3.5 km WNW Andora (Imperia), 550 m, UTM: 32T MP2769, 10.iv.1988, *Dorycium pentaphyllum*, stem-mines, e.l. 20.v.1988, EvN no. 88111, E.J. van Nieuwerken (RMNH). – Paratypes: 43 ♂, 13 ♀, 25 larvae. – Austria: 1 ♂, Deutsch Altenburg, Pfaffenberg (Niederöst.), UTM: 33U XP43, 24.viii.1935, [Preissecker] (NHMW) [paralectotype *orientella* Klimesch]; 8 ♂, Hundsheimer Berg (Niederöst.), UTM: 33U XP43, 17.viii.1973, 28.vi.1976, 9.vi.1977, 3.vii.1977, 3.ix.1977, 22.v.1979, 12.ix.1979, F. Kasy (NHMW, RMNH); 1 ♂, Marchegg, Oberweiden (Niederöst.), UTM: 33U XP44, 6.ix.1931, [Preissecker] (NHMW) [paralectotype *orientella* Klimesch]; 1 ♂, Mödling, Frauenstein (Niederöst.), UTM: 33U WP92, 26.vi.1902, Preissecker (NHMW).

[paralectotype *orientella* Klimesch]. – Czechoslovakia: 2 ♂, Hrádok n. V. (Slovakia), UTM: 33U YP19, 17.vi.1988, A. Laštúvka; 2 ♂, Zádiel (Slovakia), UTM: 33U DU88, 7.vi.1989, A. Laštúvka (coll. Laštúvka, RMNH). – Greece: 1 ♂, Kardhamili (Messiniás), gorge, UTM: 34S FF1084, 18.ii.1990, *Dorycnium hirsutum*, stem-mines, e.l. 15.iv.1990, EvN no. 90063, E. J. van Nieuwerken (RMNH). – Italy: 1 ♂, Andora, Testico (Savona), UTM: 32T MP27, 2.vii.1983, B. Å. Bengtsson (coll. Bengtsson); 3 ♂, 2 ♀, Conna (Savona), 300 m, UTM: 32T MP27, 10.ix.1977, 1.i.x.1978, 22.vi.1979, G. Baldizzone (GBA, RMNH); 4 ♂, 6 ♀, 1 larva, M. Bondia, Villa Faraldi, 3.5 km WNW Andora (Imperia), 550 m, UTM: 32T MP2769, 10.iv.1988, *Dorycnium pentaphyllum*, stem-mines, e.l. 19.v.1988-4.vi.1988, EvN no. 88111, E. J. van Nieuwerken (RMNH); 5 ♂, Poggio di Casasco, Val Currone (Al), 300 m, UTM: 32T NQ06, 06.vi.1987, G. Baldizzone (GBA, RMNH). – Spain: 1 ♂, 1 ♀, 6 larvae, 2.5 km SW Beires, along road Beires-Fondón (Almería), 1000 m, UTM: 30S WF1495, 10.i.1988, *Dorycnium pentaphyllum*, stem-mines, e.l. 20.v.1988-26.vi.1988, EvN no. 88017, van Nieuwerken & Richter (RMNH); 1 ♂, Collado de Falset (Cataluna), UTM: 30T CF15, 3.vii.1967, E. Arenberger (LNKD); 1 ♂, 2 ♀, 18 larvae, Sierra Blanca, Refugio de Juanar, 3 km NW Ojén (Málaga), 840 m, UTM: 30S UF3149, 15.i.1988, *Dorycnium hirsutum*, stem-mines, e.l. 20.v.1988-8.vi.1988, EvN no. 88048, van Nieuwerken & Richter (RMNH); 2 ♀, Sierra de Marbella, El Mirandor (Málaga), 700 m, UTM: 30S UF34, 21.vii.1987, E. Traugott-Olsen (ETO); 2 ♂, road Baza-Benamaurel, 15 km from Baza (Granada), UTM: 30S WG25, 16 and 17.vii.1987, Baldizzone & Traugott-Olsen (GBA). – Soviet Union: 1 ♂, Parkovo, southcoast Crimea (Krim), UTM: 36T WQ9(southeast), 26.v.1984, Zaguljaev (ZMAS). – Yugoslavia: 7 ♂, Krk, Draga Baska (Kroatia), UTM: 33T VK78, 27.vii.1976, 28.viii.1978, 15.viii.1988, G. Baldizzone (GBA, RMNH); 1 ♂, Krk, Skrpici (Kroatia), UTM: 33T VK68, 04.viii.1977, G. Baldizzone (GBA).

Additional material. – Spain: mines, 3 km NE Marbella, road to Ojén (Málaga), 200 m, UTM: 30S UF3244, 15.i.1988, *Dorycnium hirsutum*, EvN no. 88046, van Nieuwerken & Richter (RMNH).

Additional records. – Czechoslovakia: Čebovce (UTM: 34U CU63), Jablonov (34U DV83), Kiarov (34U CU83), Hustopeče (33U XQ22), Zaječí, larvae and adults, 1990, leg. A. and Z. Laštúvka (Z. Laštúvka in litt.).

Description

Male (fig. 6). – Forewing length 2.3-3.0 mm (2.57 ± 0.18, 26), wingspan 4.9-6.5 mm. Head: frontal tuft yellowish white to pale yellowish orange, collar paler. Antenna with 37-43 (40.1 ± 2.1, 22) segments; scape white, usually with some brown scales. Forewing and thorax covered with fuscous tipped scales, distal 1/4 to 1/3 of scales dark, edge darker, total impression greyish brown, occasionally few white scales exposed at dorsum; terminal cilia white beyond indistinct cilia-line. Underside of forewing with very large costal fold along basal third, completely covering a pocket with yellow androconial scales of about one quarter wing width (figs. 20, 58). Hindwing with pronounced humeral lobe, along costa with long snow-white hair-scales, inserted on underside, in rest fitting in forewing fold; imme-

diate behind frenulum a small group of closely set, short dark fuscous special scales (figs. 21, 22, 58).

Female. – Forewing length 2.2-2.8 mm (2.52 ± 0.19, 11) wingspan 4.9-6.1 mm. Antenna with 35-38 (36.7 ± 1.3, 10) segments.

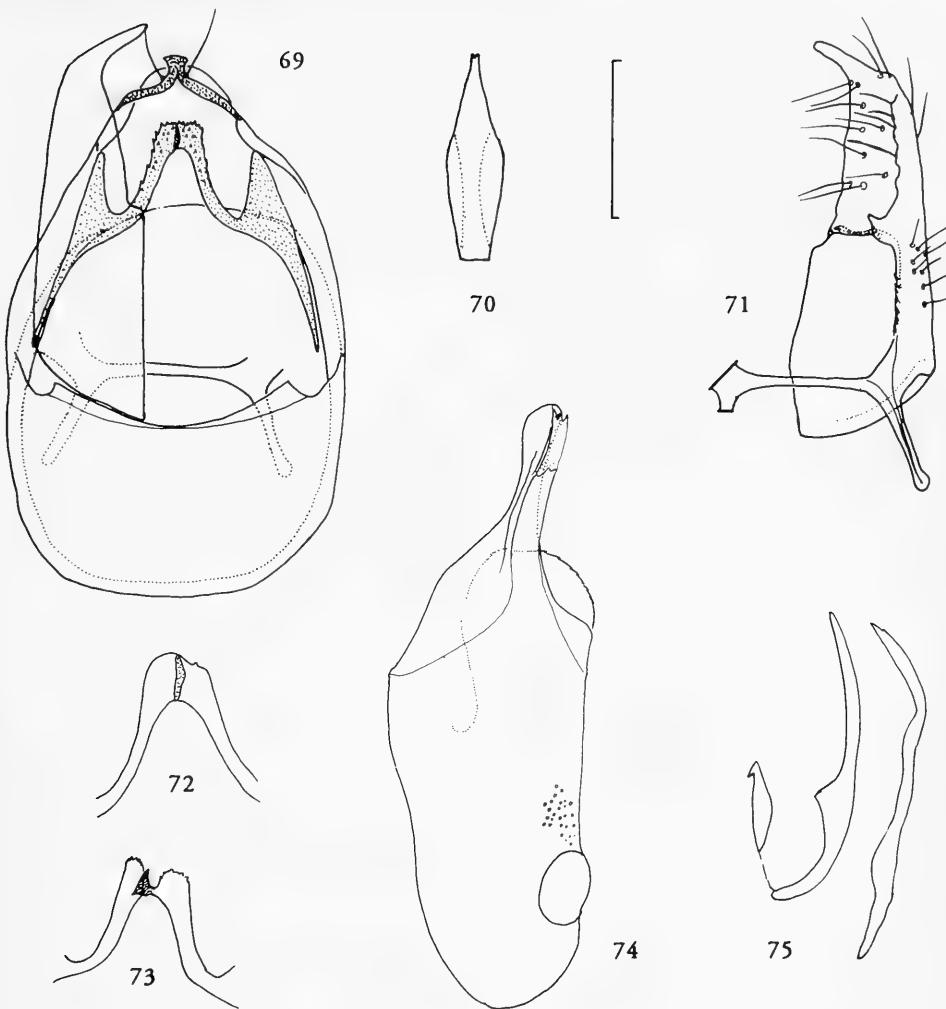
Male genitalia (figs. 69-75) – Capsule length 340-385 µm (363.6 ± 14.5, 11). Vinculum anteriorly truncate. Uncus with medial process distinctly widened terminally and truncate. Gnathos slightly or not asymmetrical, central element narrowly spatulate, with a medial keel ventrally, margins often serrate, additional spines may occur on ventral surface, but specimens without any spines and smooth margin do occur (figs. 69, 72, 73); anterior apodemes conspicuous. Valva length 260-290 µm (273.6 ± 8.3, 11), almost triangular, with inward curved tip; dorsally with a row of several spines along continuation of lateral arm of transtilla, transverse bar of transtilla slightly longer than sub-lateral processes to twice as long. Aedeagus 335-385 µm (360.0 ± 17.3, 11) long, with ventral carina fringed or bifid, aedeagal tube terminally spatulate, dorsal lobe prominent at right side, with serrate margin; vesica with two large spine-like cornuti, one (155-200 µm, 175.5 ± 13.5, 10) basically joined to a conical cornutus (50-90 µm, 59 ± 11.4, 10), the other subterminally bent, partly hidden amongst group of spine-like cornuti (not measurable); small cornuti numerous. Juxta fig. 70.

Female genitalia (figs. 93, 99). – Terminalia distinctly pointed. T8 with 6-15 setae and some scales; posterior margin truncate; anal papillae with 9-21 setae. Anterior apophyses laterally widened. Ductus spermathecae with 4½ to 5 coils. Signa 340-500 µm long, almost completely similar in length.

Final instar larva (fig. 104) – Yellow, elongate. Headcapsule 375-425 µm long, 1.01-1.11 (1.06 ± 0.03, 6) × as long as wide (in one specimen 1.19 ×). Headcapsule distinctly longer than in *subnitidella* and *coronillae*. Spinosity: prothorax ventrally with spinose band posteriorly, meso- and metathorax ventrally with a band along anterior margin and few spines laterally. Abdominal segments 1-9 with spines ventrally, not conspicuous; segment 10 with small group of spines anterior of setae.

Diagnosis

Male immediately recognized by large costal fold, hiding the yellow patch (N.B. this fold may be difficult to see in well mounted specimens!), the humeral lobe of the hindwing and the black scales near the frenulum. Male genitalia in particular characterized by gnathos with medial keel, but note variability in gnathos! Female similar to other species in the group, but easily separated by the pointed postabdomen.



Figs. 69-75. *Trifurcula josefklimeschi*, male genitalia. – 69, Capsule, valva outlined, slide 2590; 70, Juxta, slide 2590; 71, Valva, dorsal aspect, slide 2590; 72, 73, Gnathos, showing variation, respectively slides 3068 and 2744 (holotype); 74, Aedeagus, ventral aspect, holotype, slide 2744; 75, Large cornuti, separately drawn, holotype. Scale 0.1 mm.

Biology

Hostplants. – *Dorycnium hirsutum* (L.) Ser. and *D. pentaphyllum* Scop., both perennial herbs or small shrubs, widely distributed in southern Europe, probably also on the other two European *Dorycnium* species (*D. rectum* (L.) Ser. in DC. and *D. graecum* (L.) Ser. in DC.).

Life history. – Egg usually deposited on the underside of a leaflet, occasionally on the stem. When in a leaflet, the larva starts with a short and narrow linear mine (fig. 105), leading either in a straight or slightly contorted course towards the petiole, through which it enters the stem (fig. 105). The

larva then usually feeds downward first, in a rather straight line, often doubling back once or twice, before the larva quits the mine through a semicircular slit. The whole course of the mine often staining reddish or brown, frass hardly visible externally, larva visible as a yellow swelling in the stem. The mine is frequently in the more terminal shoots, and can relatively easily be found because of the staining. When full-grown larvae or empty mines are collected, the leaflet with the early mine has often already been fallen.

Larvae have been found in January, February and early April. Adults emerged in mid April (from

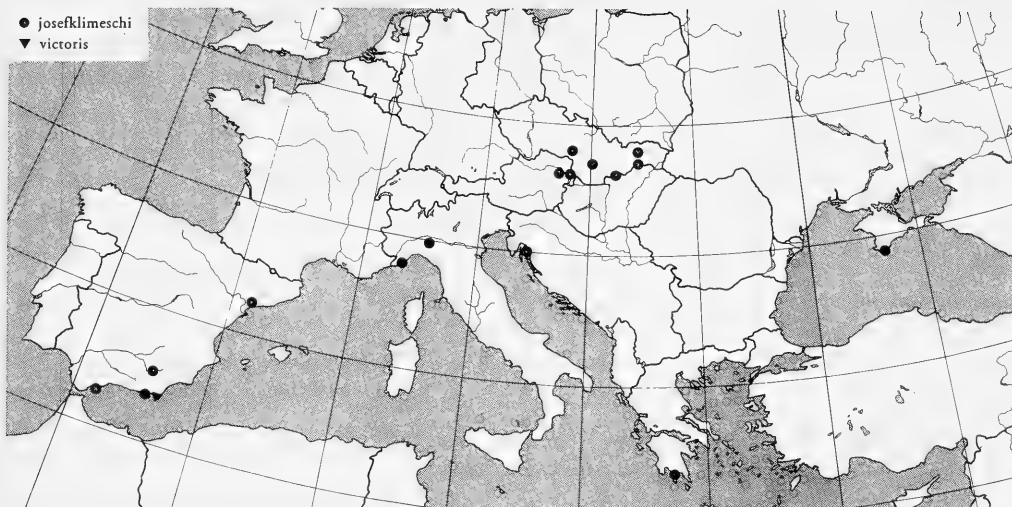


Fig. 76. Distribution of *Trifurcula victoris* and *T. josefkimeschi*, mapped on 50 × 50 km UTM squares.

Greece), the second half of May and in June (indoor rearing), but were caught from late May until the 12th of September, the largest numbers being taken in June and from late August until early September. This pattern might indicate a bivoltine cycle, but this should be confirmed by finding larvae in summer.

Distribution (fig. 76)

Widely distributed in southern Europe, from southern Spain eastward to the Crimea, northwards to eastern Austria and Slovakia. Not yet recorded, but to be expected from Portugal, France, Hungary, Rumania, Bulgaria and Turkey.

Remarks

Material of this species has long been known in collections, but was incorrectly identified as *Trifurcula orientella* Klimesch. In fact, all four specimens from Austria, listed amongst the type-material by Klimesch (1953: 169) appeared to belong to this species, which clearly differs from the specimen which genitalia were illustrated by Klimesch (1953: fig. 15) and is selected lectotype of *orientella* below.

Etymology

A noun in genitive case, named in honour of Dr. Josef Klimesch, who did much pioneer work on the genus *Trifurcula* and on mediterranean Nepticulidae in general.

8. *Trifurcula iberica* sp. n. (figs. 29, 59, 77-82)

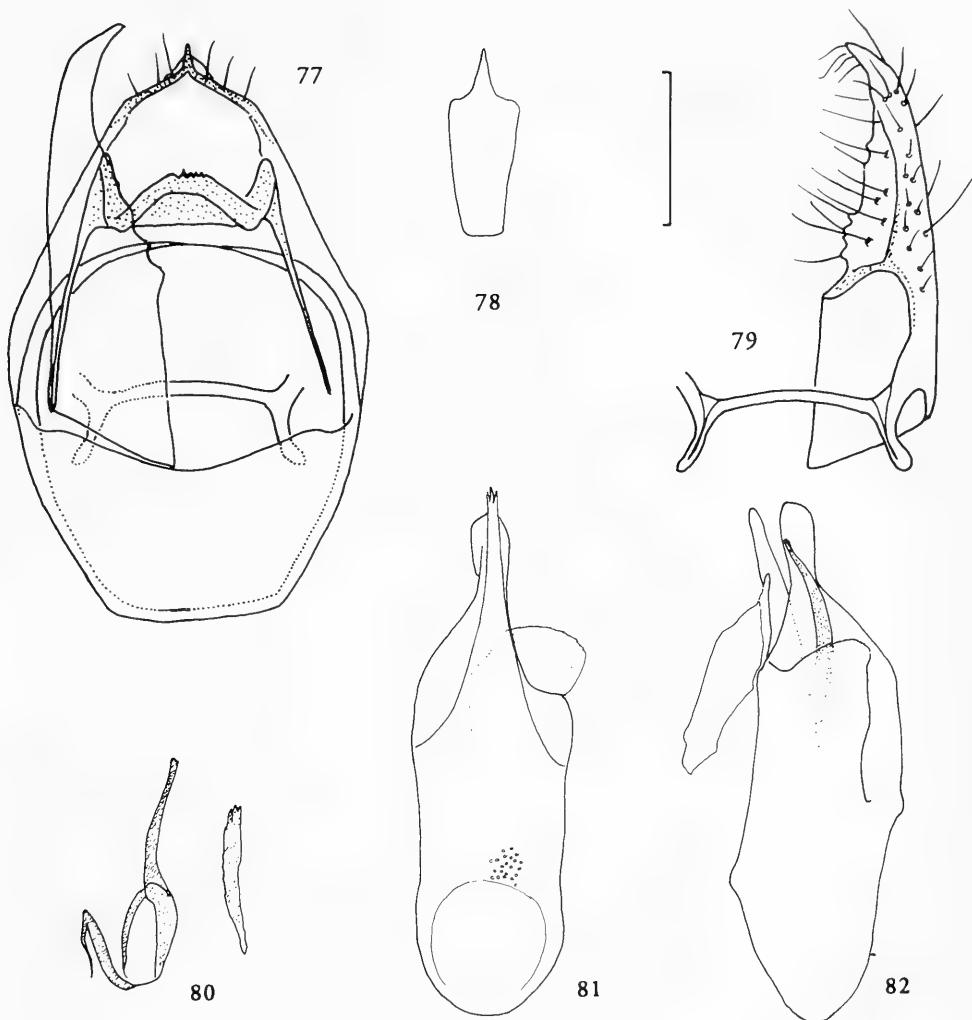
Type material. – Holotype ♂: Spain, Sierra Nevada, road to Veleta (Granada), 1700 m, UTM: 30S VG60, 9.vii.1971, E. Arenberger (LNKD). – Paratype: 1 ♂: Spain, Pyrenees, Prullans, 900 m, UTM: 31T CG99, 2.vii.1980, G. Derra (coll. Derra).

Description

Male. – Forewing length 2.7-3.2 mm, wingspan 6-7.2 mm. Head: frontal tuft ochreous yellow, collar paler. Antenna with 37-40 segments; scape yellowish white, with some brown scales. Forewing and thorax covered with brown tipped scales, total impression pale brown; terminal cilia white beyond more or less distinct cilia-line. Underside of forewing with basal patch of yellow androconial scales extending to $\frac{1}{4}$. Hindwing with white hair-scales instead of costal bristles; along costa a row of short but conspicuous black special scales, running from $\frac{1}{4}$ to middle of hindwing (fig. 59).

Female unknown.

Male genitalia (figs. 77-82) – Capsule length 345-355 μm . Vinculum anteriorly truncate, rather narrow. Uncus with medial process pointed, some lateral setae present. Gnathos almost symmetrical or slightly asymmetrical, central element truncate to rounded, posterior margin distinctly serrate; anterior apodemes present. Valva length 275 μm , narrow triangular, gradually narrowed towards tip, dorsal excavation less than half length; transverse bar of transtilla up to three times as long as sublat-



Figs. 77-82. *Trifurcula iberica*, male genitalia, slide 2741 (77-80) and 1928 (holotype: figs. 80, 82). – 77, Capsule, valva outlined; 78, Juxta; 79, Valva, dorsal aspect; 80, Large cornuti, separately drawn; 81, Aedeagus, ventral aspect; 82, Aedeagus, lateral aspect, position of spinelike cornutus shown. Scale 0.1 mm.

Diagnosis

The male of *iberica* is easily distinguished from other species in the group by the long row of black scales on the hindwing costa. The genitalia are characterized by the almost symmetrical gnathos with serrate margin, but resemble those of *silvaea*, see there.

Biology

Hostplant and immature stages unknown. Adults taken in mountains, at medial (900 m) and

high altitude (1700 m), both in July.

Distribution (fig. 29)

Only known from two specimens from the Spanish Pyrenees and Sierra Nevada.

Etymology

A latin adjective, from *Ibericus* (= *Hibericus*), meaning Spanish, referring to the single localities in the Spanish mountains.

9. *Trifurcula silviae* sp. n.

(figs. 7, 29, 60, 83-88, 94, 100)

Type material. – Holotype ♂: France, 1 km NW Ceillac, ± 10 km S Chateau-Queyras (Htes Alpes), 1800 m, UTM: 32T LQ2449, 24.vii.1987, alpine meadow on S. slope, netted at dusk, EvN no. 87139, van Nieuwerken & Richter (RMNH). – Paratypes: 6 ♂, 1 ♀. France: 1 ♂, data as holotype (RMNH); 1 ♂, Chaner. [not traced, ?near Digne], 22.viii.1903, Chrétiens (MNHN); 2 ♂, Digne (Alp. Ht. Prov.), UTM: 32T KP78, viii.1903, (MNHN); 1 ♂, Puy Vacher [near La Grave] (Htes Alpes), [2000 m], UTM: 32T KQ88, 29.vi.1898, (MNHN); 1 ♂, Viens (Vaucluse), UTM: 31T GJ0664, 21.viii.1974, R. Buvat (coll. Buvat); 1 ♀, same data, but 8.viii.1975 (RMNH).

Description

Male (fig. 7). – Forewing length 2.6-3.1 mm (2.80 ± 0.18 , 6), wingspan 5.8-7.0 mm. Head: frontal tuft pale yellow, mixed with white, collar yellowish white. Antenna with 35-39 segments (36.5 ± 1.5 , 6); scape white. Forewing and thorax relatively pale ochreous yellow, scales with ochreous brown tips mixed with completely white scales; terminal cilia white, cilia-line obsolete or absent. Underside of forewing without patch of androconial scales, narrow costal fold relatively well developed, edged with row of brown scales (fig. 60). Hindwing almost white, costa of humeral lobe with row of short dark brown scales, running to $\frac{1}{2}$ (fig. 60).

Female. – Forewing length 2.6 mm, wingspan 5.8 mm. Antenna with 32 segments.

Male genitalia (figs. 83-88) – Capsule length 300-330 μm . Vinculum anteriorly truncate. Uncus with medial process truncate, not widened, with several lateral setae. Gnathos slightly or not asymmetrical, central element narrow, posterior margin distinctly serrate; anterior apodemes hardly visible. Valva length 215-240 μm , narrow triangular, tip short pointed, slightly curved, transverse bar of transtilla about 1.5 times as long as sublateral processes. Aedeagus 310-340 μm long, with ventral carina fringed, aedeagal tube apically pointed, dorsal lobe at right side prominent, margin serrate; vesica with long pointed cornutus (140-210 μm), basally joined to conical cornutus (75 μm), a long cornutus with serrate tip hidden amongst group of long needle-like cornuti, many small cornuti present. Juxta fig. 84.

Female genitalia (figs. 94, 100). – Terminal segments broadly rounded. T8 with about 6 setae and few scales; anal papillae with 23-25 setae. Ductus spermathecae with 4 coils. Signa 335-365 μm long.

Diagnosis

Male differs from all other species in the *subnitidella* group by the absence of the yellow patch, it is also paler than most species, except *luteola*. *T. silviae* male differs from other pale *Trifurcula* species of similar size by the distinct rows of brown

scales along costal fold of forewing and along hindwing costa. Male genitalia differ from similar *iberica* by relatively longer sublateral processes and slightly broader valva. Female differs from other species described here by paler colour and blunt ovipositor.

Biology

Hostplant and immature stages unknown. The holotype and one paratype were collected in an alpine meadow on a steep southern slope, where the Fabaceae *Lotus corniculatus* L., *Anthyllis vulneraria* L. and *Onobrychis montana* DC. are the most likely candidates to be its host. The species apparently occurs over a wide range of habitats, from almost lowland mediterranean localities (Viens, Digne), to high alpine country (Ceillac: 1800 m, Puy Vacher: ca 2000 m.). Adults have been caught from June to August.

Distribution (fig. 29)

Only known from a relatively small area in southeastern France, in the Alps and pre-alps.

Remarks

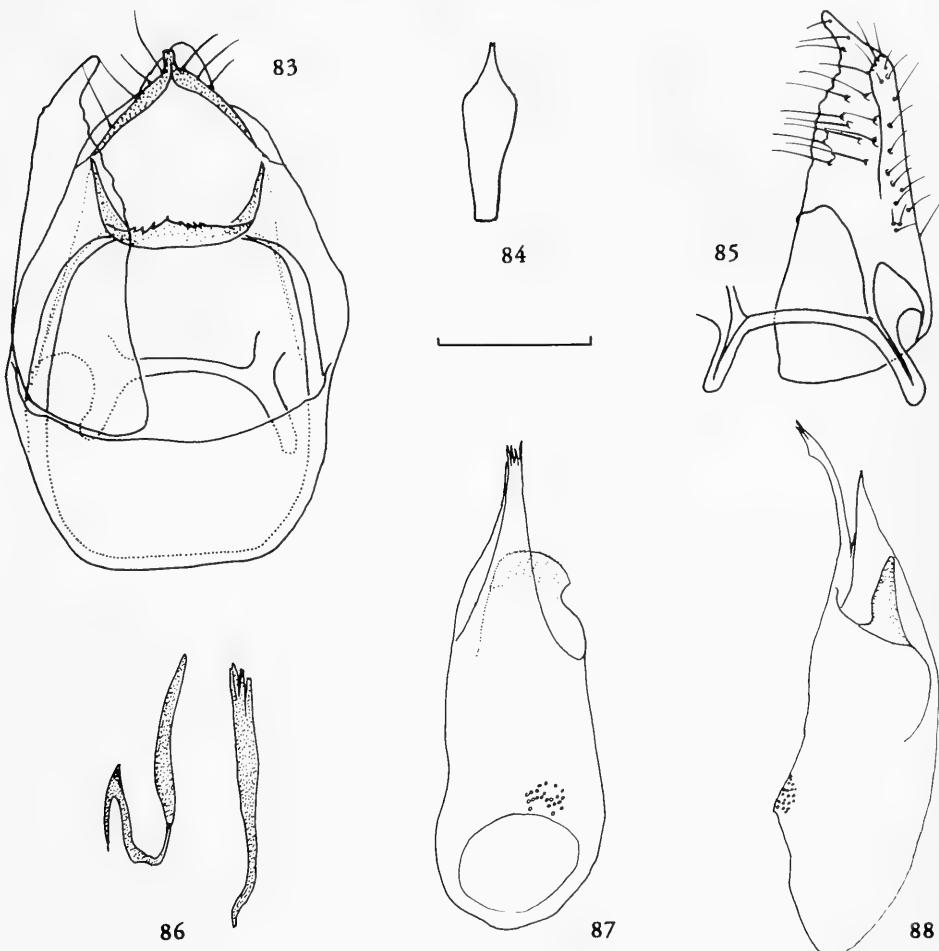
The specimens in the Chrétiens collection were found amongst material of *T. immundella*, together with a number of other misidentified species. The single female is considered to belong to *silviae* on the basis of its occurrence with one male and no other related species, the external characters and the genitalia, which clearly belong to a species in the *subnitidella* group.

Etymology

A noun in genitive case, named in honour of my wife Silvia Richter, who not only collected both holotype and one paratype, during an alpine mountain hike, but contributed much to the collecting during many joint field trips.

PHYLOGENY OF THE TRIFURCULA SUBNITIDELLA GROUP

The phylogeny of the genus *Trifurcula* and its three subgenera has been dealt with by Scoble (1980) (with the present subgenera as genera) and van Nieuwerken (1986b). In these studies it has been shown that the subgenus *Glaucolepis* Braun (= *Fedalmia* Beirne) is the sistergroup of [*Levarchama* Beirne + *Trifurcula* s.str.] and that the latter two subgenera are sistergroups to each other. Both the monophyly of the genus and subgeneric clades has been amply demonstrated by apomorphies, to which little is to be added. Only one more apomorphy for *Levarchama* has been mentioned by van Nieuwerken & Johansson (1990): the costal hair-pencil on the hindwing underside. The apomorphy for *Trifurcula* s. str: uncus divided dorsoventrally needs to be re-examined: in my opinion



Figs. 83-88. *Trifurcula silvae*, male genitalia. – 83, Capsule, valva outlined, holotype, slide 2742; 84, Juxta, slide 2604; 85, Valva, dorsal aspect, holotype; 86, Large cornuti, separately drawn, slide 2606; 87, Aedeagus, ventral aspect, slide 2606; 88, Aedeagus, lateral aspect, holotype. Scale 0.1 mm.

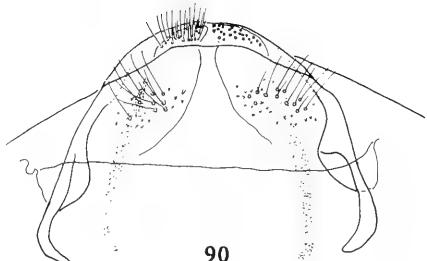
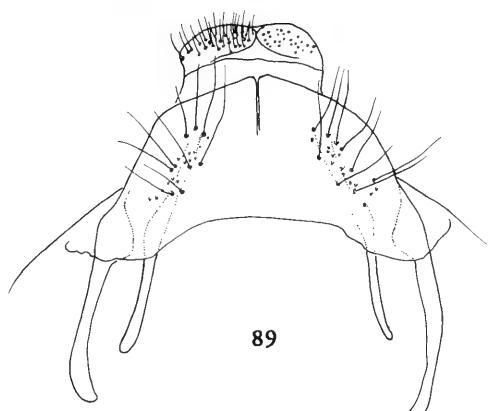
the ventral less sclerotized part, interpreted as part of the uncus by Scoble (1980), might well be a somewhat better sclerotized anal tube. This needs to be confirmed by detailed examination of whole mounts of complete genitalia, and might still be an apomorphy for the subgenus. In any case, a new interpretation of this character does in no way jeopardize the monophyly of *Trifurcula* s. str.

The phylogeny within this subgenus has not been discussed before, except the position of the two South African species, discussed by Scoble (1980), who could not solve the question whether they together form the sistergroup of [*Levarchama* + *Trifurcula*] or the sistergroup of Palaearctic *Trifurcula* s. str. I will come back to that question below,

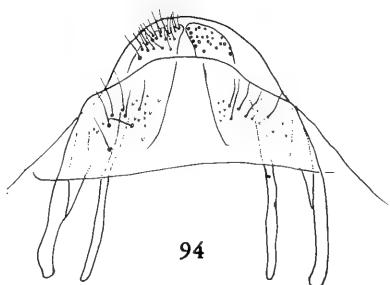
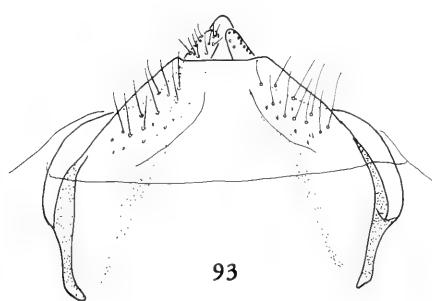
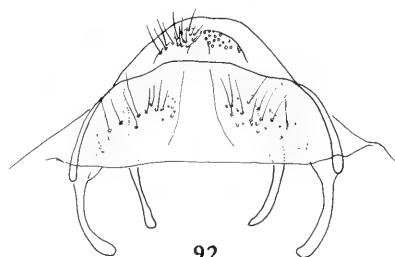
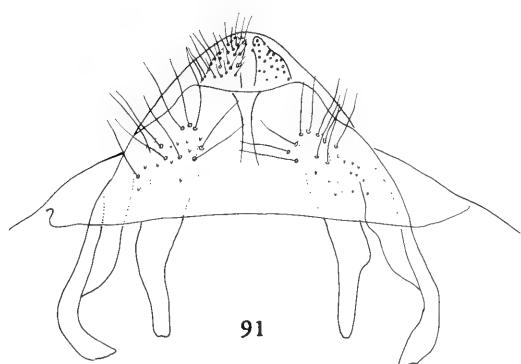
and first concentrate on the Palaearctic species.

For an evaluation of the polarity of characters, *Levarchama* has been used as outgroup. In this study *Trifurcula* s. str. has been divided in two species groups, which are believed to be monophyletic sistergroups. The phylogeny of the *subnitidella* group is presented in the cladogram in fig. 108. Monophyly of the *subnitidella* group is actually based on one character only:

1. Male forewing with patch of yellowish androconial scales on underside, near wingbase. Such androconial scales are absent in *Levarchama* and in the *pallidella* group, and not completely similar scales are only found in a subgroup of *Glaucolepis*, so that



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Figs. 89-94. *Trifurcula* spp., female postabdomen, dorsal aspect. - 89, *T. puplesia*, slide 2763; 90, *T. coronillae*, slide 2750; 91, *T. victoris*, slide 2751; 92, *T. subnitidella*, slide 2746; 93, *T. josefklimeschi*, slide 2748; 95, *T. silvae*, slide 1818. Scale 0.1 mm.



Figs. 95-100. *Trifurcula* spp., female genitalia. – 95, *T. puplesia*, slide 2763; 96, *T. coronillae*, slide 2750; 97, *T. victoris*, slide 2752; 98, *T. subnitidella*, slide 2746; 99, *T. josefklimeschi*, slide 2748; 100, *T. silviae*, slide 1818.

101



102



103



104



Figs. 101-104. *Trifurcula* spp., final instar larva, headcapsule. – 101, *T. coronillae*, Spain, Istan; 102, *T. victoris*, Spain, San José; 103, *T. subnitidella*, Netherlands, Kunrade; 104, *T. josefklimeschi*, Spain, Sierra Blanca.

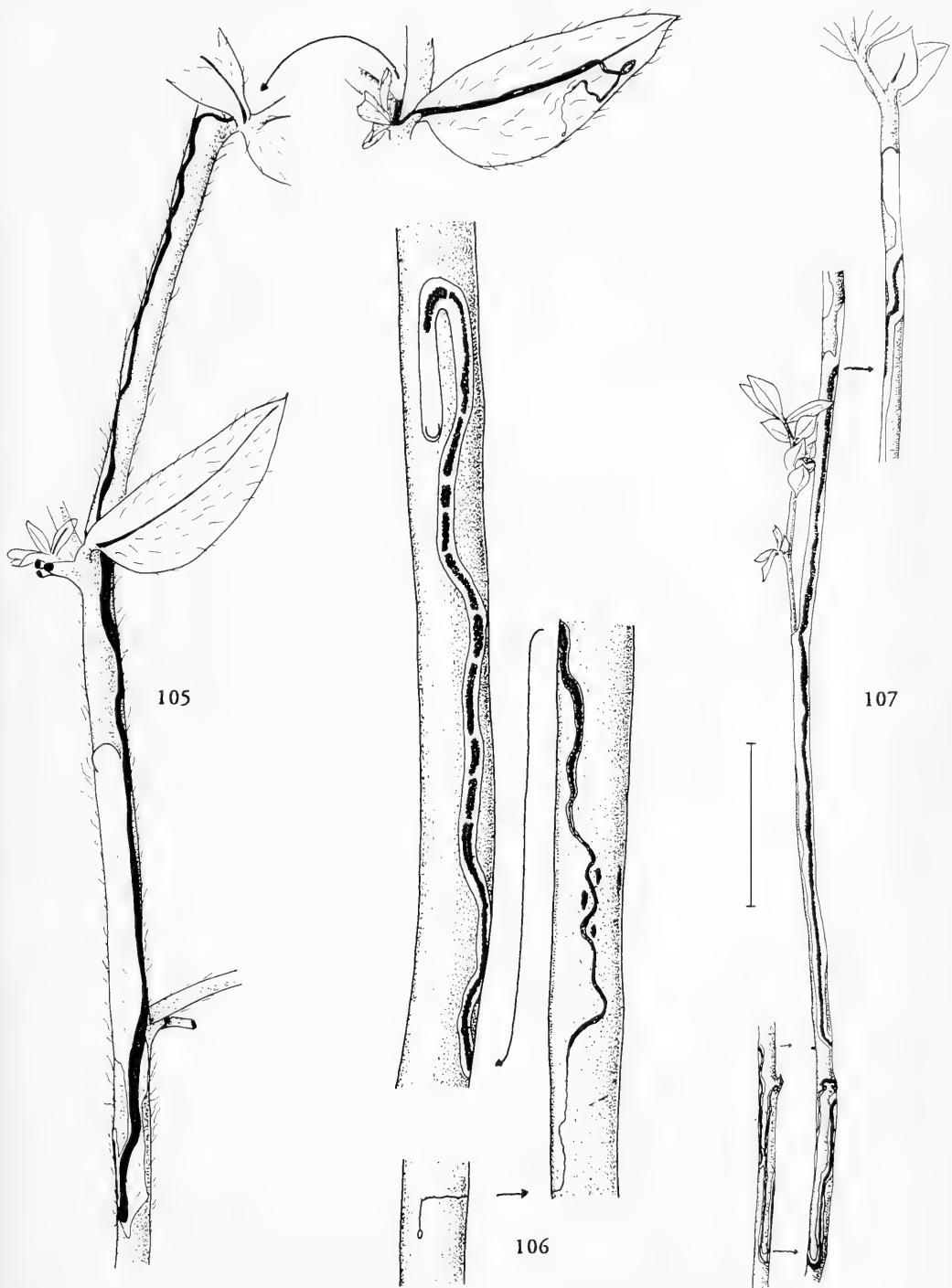
the presence of these scales is regarded as an evolutionary novelty. They are secondarily lost in *silviae*, which can be regarded to belong to the *subnitidella* group on the basis of other characters.

The *pallidella* group is believed to be monophyletic on the basis of at least the following apomorphy:

2. Hostplant belonging to the Genisteae ('brooms'). The hostplants of *Levarchama* and the *subnitidella* group belong to other tribes of Fabaceae: Loteae and Coronilleae, thus on the basis of the outgroup rule, a hostplant belonging to Loteae or Coronilleae is the plesiomorphous condition, and hence Genisteae apomorphous. No other Nepticulidae are known to feed on brooms. Although only few species have actually been reared, evidence is accumulating that indeed all species are associated with brooms.

3. A doubtful apomorphy is the form of the larger cornuti: two are curved and one is spine-like in virtually all species.

The current position of the first species of the *subnitidella* group, *T. austriaca*, is tenuous. It is included here solely on the basis of the yellow patch and the general external resemblance to other species in the group. The genitalia, in particular the aedeagus, resemble more the *pallidella* group, although they show some peculiarities, not noticed in other species, such as the curved carinal lobes. If the aedeagal characters (shape of cornuti, dorsal lobe) belong to the groundplan of the subgenus, and *austriaca* has no broom species as host, it still belongs to the *subnitidella* group, and possibly is the sister-species of all other species together. On the other hand, if it is found to have a species of broom as



Figs. 105-107. Larval stem-mines of *Trifurcula* species. – 105, *T. josefklimeschii*, mine in *Dorycnium hirsutum*, Spain, Sierra de Marbella; 106, *T. coronillae*, mines in *Coronilla juncea*, type locality; 107, *T. subnitidella*, mines in *Lotus corniculatus*, Netherlands, Kunrade. Scale 1 cm.

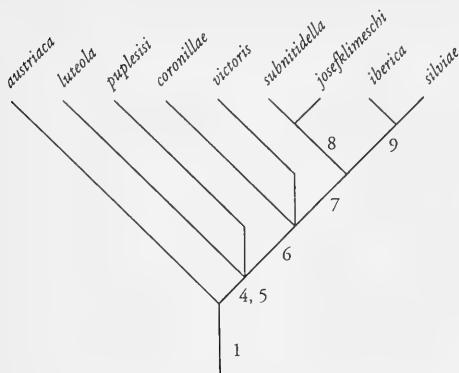


Fig. 108. Cladogram of *Trifurcula subnitidella* group, numbers refer to apomorphies, explained in text.

host, it is possibly misplaced here meaning that the androconial patch has apparently evolved twice independently, or that it should be regarded as an underlying apomorphy. Awaiting further information of this species, *austriaca* is tentatively treated here in the *subnitidella* group.

The remaining eight species share the following characters as apomorphies:

4. Aedeagus terminally narrowed, dorsal lobe well developed, at right side or in middle; often with serrate margin.

5. Pattern of the three large cornuti: one spine-like, basally joined with a conical, and a long irregular (often spine-like) cornutus hidden amongst the group of needle-like cornuti.

The first branching in this clade has not been resolved, and is provisionally presented as a trichotomy. The species *luteola* and *puplesisi* resemble each other closely, but the similarities seem to be mere plesiomorphies, so that their phylogenetic relationship cannot be demonstrated. The remaining six species form a better defined monophyletic entity on the basis of the apomorphy:

6. Gnathos highly atypical for Nepticulidae, with keels and/or serrations, often highly asymmetrical. The gnathos of the previous species resembles that of the *pallidella* group, it is symmetrical and never with keels, and thus forms the plesiomorphic condition within the subgenus.

Also in the next clade the first branching is presented as a trichotomy, since the monophyly of [*coronillae* + *victoris*] could not be demonstrated. The monophyly of the final four species is based on the following unique character:

7. Hindwing costa in male with characteristic black or dark brown androconial scales

T. subnitidella and *josefklimeschii* are tentatively regarded as sister-species on the basis of their similarity and one possible apomorphy:

8. Black scales along hindwing costa confined to small group close to frenulum.

Finally, *T. iberica* and *silviae* most likely are sister-species, also on the basis of a general similarity in habitat, externals and genitalia of which the following character might be regarded as apomorphy:

9. Gnathos without keels, but with serrated margin.

The phylogeny of the *subnitidella* group is still based on relatively few characters, more detail of females, immature stages and hostplants would be most welcome in order to refine the cladogram.

One final point to discuss here, is the phylogenetic position of the two South African species, described by Scoble (1980).

Only males are known from these species, so that we have no biological data to support our theories. In my opinion both species definitely belong to *Trifurcula* s. str. on the basis of the group of needle-like cornuti, an apomorphy for the subgenus, and the absence of a split uncus (in ventral view), a character for *Levarchama*. However, the hair-pencil of *T. barbertonensis* Scoble (fig. 12 in Scoble), closely resembles that of *Levarchama*, which might suggest another solution. Since no biological data are available, and since it is unknown whether these species have a patch of androconial scales on the forewing underside, it is yet impossible to assign them to one of the Palaearctic species groups. The aedeagus as figured by Scoble (1980) seems to be different from both species groups, so that it is still possible that the South African species form the sistergroup of the Palaearctic *Trifurcula* s. str.

APPENDIX

Trifurcula orientella Klimesch

Trifurcula orientella Klimesch, 1953: 168, 169, fig. 15.

Lectotype ♂ (here designated): Yugoslavia, Dalmatia mer., Umg. v. Gravosa, 15-31.v.1939, J. Klimesch, 'Holotypus', genitalia slide Kl. 511 (coll. Klimesch) [examined].

Trifurcula orientella was described on the basis of six male specimens from Gravosa, Yugoslavia and four male specimens from Austria. When I found the austrian specimens in the Vienna museum, they appeared to have genitalia differing from the figure, presented by Klimesch, and actually appear to belong to the species here described as *josefklimeschii*. Since Klimesch's figure clearly has been the basis for the identity of *orientella*, it seems most appropriate to select the specimen used for this figure as lectotype. This is also the specimen labelled by Klimesch 'Holotypus'. Unfortunately, two other paralectotypes from the type locality, examined by me, also appear to belong to another and larger

species, either *T. immundella* Zeller or a closely related species, which has been reared by me from *Calycotome*. The remaining three paralectotypes have not been examined by me.

T. orientella is a relatively small species, clearly belonging to the *pallidella* group, which is known from the Dalmatian coast, the isle of Krk (leg. Baldizzone) and from Conna on the Italian Riviera. From the latter locality I have reared this species from stem-mines in the broom *Genista germanica* L.

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REFERENCES

Arnett, R. H. & G. A. Samuelson, 1986. The insect and spider collections of the world. 220 pp. - E.J. Brill/Flora & Fauna publications, Gainesville.

Bjørn, & G. Pallesen, 1971. Fund af småsommerfugle fra Danmark i 1970. - Flora og Fauna, Århus 77: 107-111.

Bradley, J. D., 1962. Lepidoptera in Ireland, May, 1961. Part III: Descriptions of *Coleophora pappiferella* Hofmann, *Trifurcula griseella* Wolff, and *Nepticula serella* Stainton, with biological notes. - Entomologist's Gazette 13: 171-177.

Bradley, J. D. & D. S. Fletcher, 1986. An indexed list of British Butterflies and Moths. vi+119 pp. - Kedleston Press, London.

Bradley, J. D., D. S. Fletcher & P. E. S. Whalley, 1972. Kloet and Hincks. A checklist of British Insects. Second Edition (Revised) part 2: Lepidoptera. - Handbooks for the Identification of British Insects 11(2): i-viii, 1-153.

Buhl, O., O. Karsholt, K. Larsen, G. Pallesen, E. Palm & K. Schnack, 1983. Fund af småsommerfugle fra Danmark i 1982 (Lepidoptera). - Entomologiske Meddelelser, 50: 119-136.

Buhl, O., O. Karsholt, K. Larsen, E. Palm & K. Schnack, 1984. Fund af småsommerfugle fra Danmark i 1983 (Lepidoptera). - Entomologiske Meddelelser, 52: 1-21.

Buhl, O., O. Karsholt, K. Larsen, E. Palm & K. Schnack, 1987. Fund af småsommerfugle fra Danmark i 1984 (Lepidoptera). - Entomologiske Meddelelser, 54: 97-112.

Buhl, O., P. Falck, O. Karsholt, K. Larsen, & K. Schnack, 1988. Fund af småsommerfugle fra Danmark i 1986 (Lepidoptera). - Entomologiske Meddelelser, 56: 99-112.

Christoph, H., 1877. Sammelergebnisse aus Nordpersien, Krasnowodsk in Turkmenien und dem Daghestan. - Horae Societas Entomologicae Rossicae 12: 1-119 [pagination of reprint].

Duponchel, P. A. J. [1842-1845]. In Godart, J.-B., Histoire naturelle des Lépidoptères ou papillons de France. Nocturnes, Supplément 4, 534 pp., pls 51-90. - Méquignon-Marvis, Paris.

Emmet, A. M., 1975. *Trifurcula griseella* Wolff, 1957 (Lep., Nepticulidae), a species previously unrecorded in England. - Entomologist's Gazette 26: 39-43.

Emmet, A. M., 1976. Nepticulidae. - In: Heath, J. (ed.): The moths and butterflies of Great Britain and Ireland 1: 171-267, pls. 1-7, 11, 12.

Heywood, V. H. & P. W. Ball, 1968. Leguminosae. - In: Tutin, T.G. et al. (eds.) Flora Europaea 2: 80-187.

Karsholt, O., 1985. Nepticulidae. - In: K. Schnack (ed.), Katalog over de danske Sommerfugle. - Entomologiske Meddelelser, 52 (2-3): 44-45.

Karsholt, O. & E. S. Nielsen, 1976. Systematisk fortegnelse over Danmarks sommerfugle. - Scandinavian Science press, Klampenborg, 128 pp.

Kasy, F., 1983. Die Schmetterlingsfauna des WWF-Naturreservates "Hundsheimer Berge" in Niederösterreich. - Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen, 34 Supplement: 1-48.

Kasy, F., 1985. Die Schmetterlingsfauna des Naturschutzgebietes "Pischelsdorfer Fischawiesen", östliches Niederösterreich. - Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen, 36 Supplement: 1-27.

Klimesch, J., 1953. Die europäischen *Trifurcula*- und *Ectoedemia*-Arten (Lep., Nepticulidae). - Zeitschrift der Wiener entomologischen Gesellschaft 38: 160-170, 191-196.

Joannis, J. de, 1915. Étude synonymique des espèces de Microlépidoptères décrites comme nouvelles par Duponchel. - Annales de la Société entomologique de France 84: 62-164.

Lhomme, L., 1935-[1963]: Catalogue des Lépidoptères de France et de Belgique 2, Microlépidoptères, 1253 pp. - Douelle (Lot).

Meess, A., 1910. Superfam. Tineides Aculeatae. - In: A. Spuler (ed.), Die Schmetterlinge Europas, 2: 464-482; 3: pl. 91. Schweizerbart'sche Verlagbuchhandlung, Stuttgart.

Nieuwerken, E. J. van, 1985. A taxonomic revision of the Western Palaearctic species of the subgenera *Zimmermannia* Hering and *Ectoedemia* Busck s.str. (Lepidoptera, Nepticulidae), with notes on their phylogeny. - Tijdschrift voor Entomologie 128: 1-164.

Nieuwerken, E. J. van, 1986a. A provisional phylogenetic check-list of the western palaearctic Nepticulidae, with data on hostplants (Lepidoptera). - Entomologica Scandinavica 17: 1-27.

Nieukerken, E. J. van, 1986b. Systematics and phylogeny of Holarctic genera of Nepticulidae (Lepidoptera, Heteroneura: Monotrysia). – Zoologische Verhandelingen, Leiden 236: 1-93.

Nieukerken, E. J. van, 1987. Taxonomy and distribution of *Trifurcula squamatella* Stanton sp. rev., a senior synonym of *T. maxima* Klimesch (Lepidoptera, Nepticulidae). – Entomologist's Gazette 38: 179-187.

Nieukerken, E. J. van & R. Johansson, 1986. *Trifurcula pallidella* (Duponchel) and *T. heinri* Puplesis (Lepidoptera: Nepticulidae): nomenclature, taxonomy and distribution. – Entomologica scandinavica 17: 271-278.

Nieukerken, E. J. van & R. Johansson, 1987. Identity of hitherto doubtful specific names in European Nepticulidae (Lepidoptera). – Zoologische Mededelingen, Leiden 61: 459-474.

Nieukerken, E. J. van & R. Johansson, 1990. Tribus Trifurculini. In: Johansson, R. et al. The Nepticulidae and Opostegidae (Lepidoptera) of NW Europe. – Fauna entomologica scandinavica 23: 239-321, pls.

Nieukerken, E.J. van, E. S. Nielsen, R. Johansson, & B. Gustafsson, 1990. Introduction to the Nepticulidae. – In: Johansson, R. et al. The Nepticulidae and Opostegidae (Lepidoptera) of NW Europe. – Fauna entomologica scandinavica 23: 11-109.

Pröse, H., 1987. Artenliste der in Bayern und den angrenzenden Gebieten nachgewiesenen Microlepidoptera (Kleinschmetterlinge). – Schriftenreihe Bayerischen Landesamt für Umweltschutz 77: 43-102.

Rebel, H., 1901. Catalog der Lepidopteren des Palaeartischen Faunengebietes. II. Theil: Famil. Pyralidae – Micropterygidae. 368 pp. – Berlin, Friedländer & Sohn.

Scoble, M. J., 1980. *Trifurcula* Zeller: a critical analysis of the genus, cladistic relationships and descriptions of two new species from South Africa (Lepidoptera: Nepticulidae). – Journal of the entomological Society of southern Africa 43: 139-150.

Svensson, I., 1974. Catalogus Insectorum Sueciae. VI. Microlepidoptera (1946). Additamenta II. – Entomologisk Tidskrift 95: 151-171.

Svensson, I., 1980. Anmärkningsvärda fynd av Microlepidoptera i Sverige 1979. – Entomologisk Tidskrift 101: 75-86.

Svensson, I., 1983. Anmärkningsvärda fynd av Microlepidoptera i Sverige 1982. – Entomologisk Tidskrift 104: 59-65.

Svensson, I., 1985. Anmärkningsvärda fynd av Microlepidoptera i Sverige 1984. – Entomologisk Tidskrift 106: 71-82.

Svensson, I., H. Elmquist, B. Gustafsson, H. Hellberg, L. Imby & G. Palmqvist, 1987. Catalogus Lepidopterorum Sueciae. Kodlista LI. 11 + 1 + 9 + 96 + 28 + 3 + 27 + 6 pp. – Naturhistoriska Riksmuseet, Stockholm.

Wagner, D. L., 1987. A new *Microcalyptis* species from California (Lepidoptera: Nepticulidae). – Pan-Pacific Entomologist 63: 278-283.

Wolff, N. L., 1957. *Trifurcula griseella* nov. spec. (Lepidoptera, Nepticulidae). – Entomologiske Meddelelser 28: 19-22.

Zeller, P. C., 1848. Die Gattungen der mit Augendeckeln versehenen blattminirenden Schaben. – Linnaea entomologica 3: 248-344.

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**STIGMELLA ROLANDI SP. N.: A WIDESpread
SOUTHERN EUROPEAN SPECIES ON ROSA
(LEPIDOPTERA: NEPTICULIDAE)**

Nieukerken, E. J. van, 1990. *Stigmella rolandi* sp. n.: a widespread southern European species on *Rosa* (Lepidoptera: Nepticulidae) – Tijdschrift voor Entomologie 133: 239-243, figs. 1-10. [ISSN 0040-7496]. Published 14 December 1990.

Stigmella rolandi sp. n., belonging to the *Stigmella sanguisorbae* group, is described from southern Europe. It has previously been misidentified as *S. spinosissimae* Waters, a western European species. The species is characterized by a costal hair pencil on the male hindwing. The distribution is mapped, and the biology described: the larva feeds on *Rosa* and *Sanguisorba*.

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Key-words. – Nepticulidae, leaf-miners, taxonomy, Palaearctic, Rosaceae.

The aim of this paper is to name a widespread species of *Stigmella*, which has been known for almost 40 years, but until recently was misidentified as *Stigmella spinosissimae* (Waters). This misidentification followed Klimesch (1951), who described the genitalia and biology of the present species, which he identified as *S. spinosissimae*, on the basis of the same hostplant (*Rosa pimpinellifolia* L.) and the description of external features by Waters (1928). Study of type material of *Nepticula spinosissimae* Waters, however, showed that this is a species in the *anomalella* species group, whereas *spinosissimae* sensu Klimesch belongs to the *sanguisorbae* species group (van Nieukerken 1986, Johansson & Nielsen 1990).

The European species of *Stigmella* Schrank are relatively well known: Johansson & Nielsen (1990) treated the 76 species of Northwest Europe in detail. Only 20 additional species from southern Europe and the Mediterranean region were listed by van Nieukerken (1986). Most of these have been satisfactorily described, including figures of male genitalia, and in some cases female genitalia, by Johansson (1971) and in papers by Klimesch (references in Johansson & Nielsen 1990). To date only about six more undescribed European species of the genus are known in collections, and not many more are expected to be found. Therefore, identification of European *Stigmella* species can be achieved with a fairly high degree of certainty. In this light, description of a single widespread new species seems justified and will facilitate identification. The other

undescribed species belong to different species groups, mainly the *ruficapitella* and *malella* species groups, and will be described in due time.

The *Stigmella sanguisorbae* group counts four species (van Nieukerken 1986): of these, *S. sanguisorbae* (Wocke) and *S. thuringiaca* (Petry) have been described and illustrated in detail by Johansson & Nielsen (1990) and *S. muricatella* Klimesch in the original description (Klimesch 1978). The fourth species is (re)described and named below.

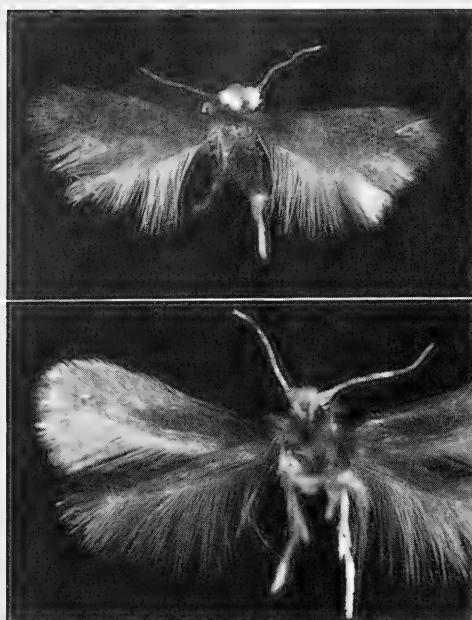
The methods and abbreviations are largely the same as in the previous paper (van Nieukerken 1990), but genitalia measurements were taken at 400 X.

***Stigmella rolandi* sp. n.
(figs. 1-10)**

[*Nepticula spinosissimae* Waters; Klimesch 1951: 4, 1958: 95, 1961: 751, Szőcs 1955: 170, 1956: 390, 1963: 108, 1965: 59, 1973: 452, 1977: 92, 1978: 267, 1981: 213. Misidentifications]

Nepticula 'spec. nov.'; Zimmermann 1944: 63.
Stigmella spinosissimae sensu Klimesch; van Nieukerken 1986: 9.

Type material. – Holotype ♂: Greece, Parnassós Oros, 5-6 km S. Polídhroson (Fókis), Abies-Pinus W., 1000-1200 m, 38.36N-22.33E [UTM: 34S FH37], 28.ix.1980, st. 59, Rosa e.l. 25/29.iv.1981, VU no 80690KE, S. B. J. Menken & E. J. van Nieukerken, Genitalia slide EvN 2780 (RMNH). – Paratypes: 81 ♂, 2 ♀. – Austria: 1 ♂, Dürnstein, UTM: 33U WP46, el 8.iv.1936, J. Klimesch



Figs. 1,2. *Stigmella rolandi*, male. – 1 (top), habitus holotype; 2 (bottom), Underside wings, showing special scales and hair-pencil, Austria.

(RMNH). – Czechoslovakia: 1 ♂, Dětkovice (Moravia), UTM: 33U XQ57, 30.viii.1988, el iii.1989, Rosa; 1 ♂, 1 ♀, Mikulov (Moravia), UTM: 33U XQ20, 29.ix.1989, el ii.1990, *Sanguisorba minor*; 2 ♂, Sl. Kras-Zádiel, UTM: 33U DU88, 15.ix.1988, el ii-iii.1989, Rosa, (all coll. A. and Z. Laštúvka) – France: 1 ♂, La Penne-sur-l'Ouvèze (Drôme), UTM: 31T FK70, 25-27.vi.1986 (coll. H. van der Wolf); 4 ♂, Viens (Vaucluse), UTM: 31T GJ06, 22.vii.1964, 24.viii.1971, 8.viii.1975, 18.viii.1976, R. Buvat (RMNH, coll. Buvat). – Italy: 1 ♂, Abruzzo, Sulmona (l'Aquila), UTM: 34T EL88, 7.viii.1982 (coll. J. H. Kuchlein); 10 ♂, Monti Aurunci (Latina), 4 km NW Castelforte, UTM: 33T VF07, 400 m, 22-23.vi, 1.vii.1969; 2 ♂, Monti Aurunci, 6 km N Itri, UTM: 33T UF77, 15.viii.1972 (coll. R. Johansson, RMNH); Sardegna, Mt. Istiddi, UTM: 31T NK12, 1.iix.1978 (coll. G. Derra); 1 ♂, Sardegna, Belvi (Nuoro), UTM: 31T: NK12, 650 m, 20.vii.1984; 1 ♂, Sardegna, Fontana Raminosa (Nuoro), UTM: 31T NK11, 900 m, 4.viii.1984; 3 ♂, Sardegna, Sarcidano (Nuoro), UTM: 31T NK00, 720 m, 1.vii.1984 (all. leg. and coll. J. H. Kuchlein). – Spain: 3 ♂, Cadalso de los Vidrios (Madrid), UTM: 30T UK8062, 7.viii.1986, E. J. van Niekerken (RMNH); 1 ♂, 8 km E of Orcera (Jaen), 1150 m, UTM: 30S WH24, 19.vii.1986 (coll. Gielis); 5 ♂, San Roque (Cadiz), UTM: 30S TF81, 26.vii.1986, C. Gielis (RMNH, coll. Gielis); 2 ♂, Vega del Codorno (Cuenca), UTM: 30T WK97, 1350 m, 23.vii.1985 (coll. J. H. Kuchlein, RMNH). – Yugoslavia: 1 ♂, Drenovo, Kavadarci (Macedonia), UTM: 34T EL88, 1-10.vi.1957, F. Kasy (NHMW); 31 ♂, 1 ♀, Krk, Misucaynica, road Krk-Vrbnik (Kroatia), UTM: 33T VK78, 20.vii-11.viii., 1986-1988, G. Baldizzone (RMNH, coll. Baldizzone); 3 ♂, Krk, Draga Baska (Kroatia), UTM: 33T VK78, 15.viii.1988 (coll. Baldizzone). – USSR, Ukraine: 1 ♂, Krim, Kara-Dag, 20 km W Feodosia,

UTM: 36T XQ78, 14.vii.1977, Reznik (ZMAS); 4 ♂, same locality, 5-22.vii.1987, R. Puplesis (ZKVV, RMNH).

Description

Male (fig. 1). – Forewing length 1.6-2.1 mm (1.88 ± 0.11, 56), wingspan 3.7-4.7 mm. Head: frontal tuft pale yellowish orange to ferruginous, collar yellowish white. Antenna fuscous, with 25-29 segments (26.6 ± 1.1, 44); scape yellowish white. Forewing and thorax dark fuscous to fuscous black, scale bases often paler greyish; terminal cilia dark grey, occasionally separated by a more or less distinct cilia line. Underside of forewing (fig. 2) with an elongated andraconial patch, extending from base to ⅓, on costal side of fold, with fuscous grey special scales, leaving a narrow furrow in middle; all scales outwards oblique towards furrow. Hindwing grey, first three to four costal bristles normal strong and short, followed by group of more than 20 hairlike costal bristles of ½ wing length, forming a hair-pencil (fig. 3), which in rest is inserted in furrow in forewing andraconial patch. Abdomen fuscous, with distinct yellowish grey anal tufts.

Female. – Forewing length 1.8-1.9 mm (N=2), wingspan 4.1-4.2 mm. Antenna with 20-22 segments. Forewing without special scales, hindwing with costal bristles of normal length. No anal tufts.

Male genitalia (figs. 4-6) – Capsule length (from tip of tegumen to central part of anterior margin of vinculum) 163-210 µm (188.4 ± 12.5, 19). Vinculum with anterior margin emarginate. Tegumen hood-shaped. Uncus distinctly bilobed, lobes separate, each with some setae on prominent sockets. Gnathos with posterior horns widely separate, transverse bar anteriorly slightly protruding at corners, forming indistinct anterior processes. Valva length 148-180 µm (164.2 ± 8.4, 17), widest beyond middle, suddenly tapering towards long curved distal process; transverse bar of transtilla long, sublateral processes small. Aedeagus 104-185 µm (146.5 ± 16.7, 17) long, tube broad, but slightly variable in dimensions. Vesica with relatively few small cornuti, some being a little larger.

Female genitalia (figs. 7, 8) – T8 with three longitudinal bands of setae and scales; anal papillae without setae. Posterior and anterior apophyses long and narrow, approximately of same length. Bursa globular, densely covered with pectinations, no signum apparent. Accessory sac small, no reticulate field visible. Ductus spermathecae without distinct coils.

Diagnosis

The male can be recognized from all other uniformly coloured *Stigmella* species by the coastal hair-pencil and androconial scales on the forewing underside. From above *S. rolandi* resembles *S. sanguisorbae* most, and females cannot be reliably separated. *S. thuringiaca* has paler olive-brown to

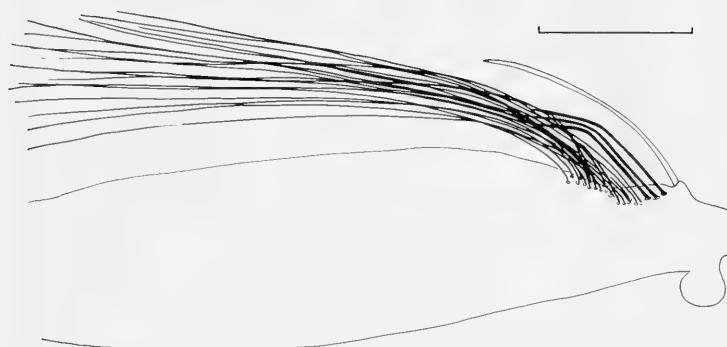


Fig. 3. *Stigmella rolandi*, male hindwing: costal bristles and costal hair-pencil (Italy: Monti Aurunci). Scale: 0.2 mm.

grey-brown and more shining forewings, is somewhat larger, and usually has a darker head. Not likely to be confused with species of the *anomallella* group, that feed on the same hosts: *S. anomallella* (Goeze) has distinct purplish wing tips, *S. spinosissimae* (Waters) has a fuscous head and bronze forewings with copper reflections and *S. centifoliella* (Zeller) has a postmedial fascia.

The male genitalia resemble also *sanguisorbae* most, but *rolandi* has much less cornuti. *S. thuringiaca* has still more cornuti, plus pectinations on the vesica and pectinate hairs on the dorsal face of the valvae. Female genitalia with smaller accessory sac than *sanguisorbae* or *thuringiaca* and without signum. See illustrations in Johansson & Nielsen (1990).

Biology

Hostplants. – *Rosa* spp., including *R. pimpinellifolia* L. (= *R. spinosissima* L.) and *Sanguisorba minor* Scop.

Mine (fig. 9). – A gallery mine. Egg deposited on under- or upperside, often near a vein. Mine often following the serrations of leaf-margin. Frass in midline, leaving very narrow white margins in early mine, but filling only about half mine width later. Larva yellow. Mines are difficult or not to separate from those of the *anomallella* group.

Life history. – Probably bivoltine. Larvae have been found in late August and September, adults reared from February to April. Early summer larvae have not yet been found, but adults are found from early June until early September, thus at least partly from a probable second generation. Adults usually taken at light.

Distribution (fig. 10)

Widespread in southern and southern central Europe: eastern Austria, eastern Czechoslovakia, southern France, Spain, Italy, Sardinia, Yugoslavia, Greece and Soviet Union: Ukraine.

Literature records: Hungary: Budapest region (Szöcs 1955, 1956, 1963, 1981), Bakony mountains

(Szöcs 1973), Matra mountains (Szöcs 1977) and Pilis mountains (Szöcs 1978).

Etymology

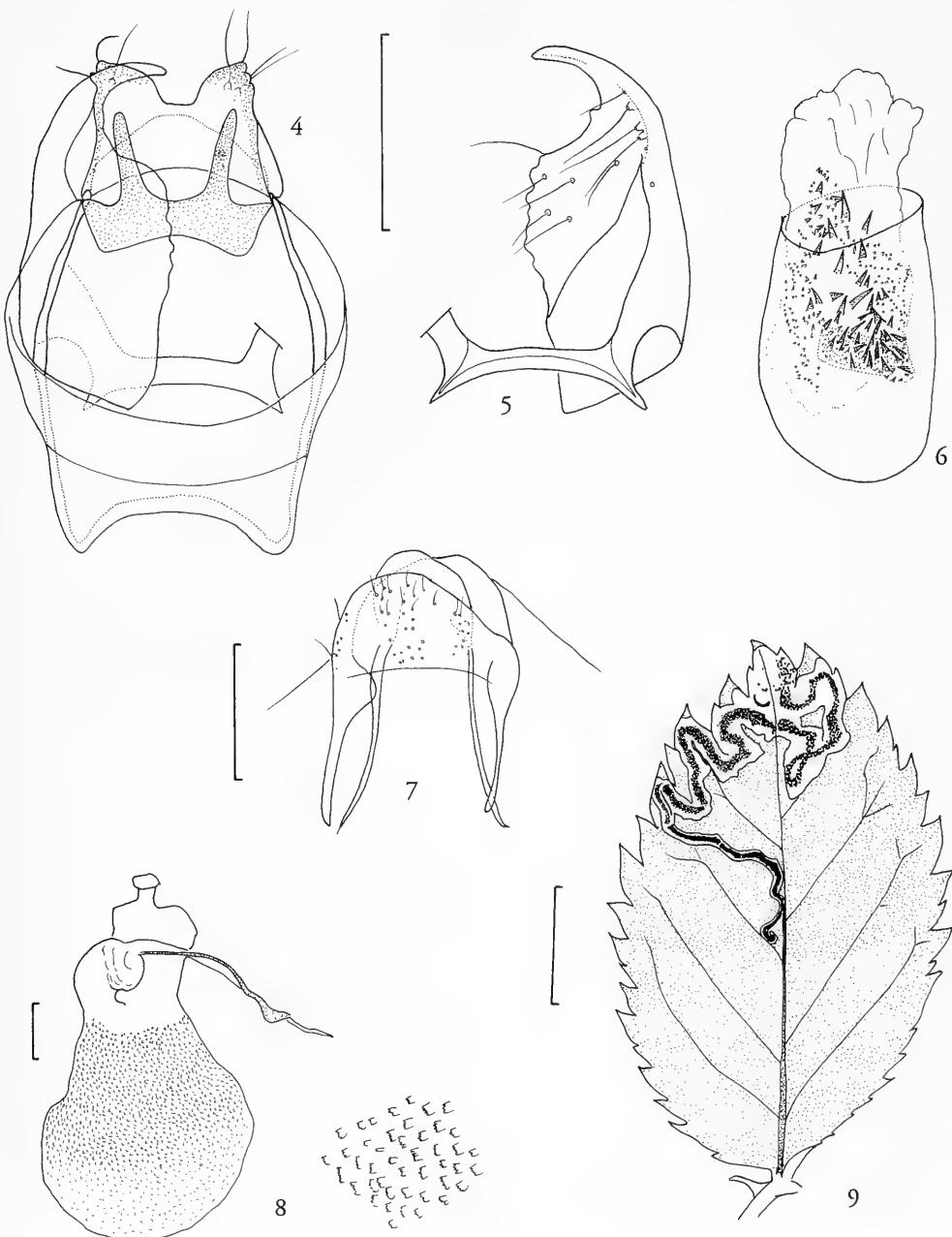
A noun in genitive singular. Named in honour of my friend Roland Johansson, specialist of Nepticulidae, and outstanding painter of these moths.

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REFERENCES

- Johansson, R., 1971. Notes on the Nepticulidae (Lepidoptera) I. A revision of the *Nepticula ruficapitella* group. – *Entomologica scandinavica* 2: 241-262.
- Johansson, R. & E. S. Nielsen, 1990. Tribus Nepticulini. – In: Johansson, R. et al. The Nepticulidae and Opostegidae (Lepidoptera) of NW Europe. – *Fauna entomologica scandinavica* 23: 111-238, pls.
- Klimesch, J., 1951. Zur Kenntnis der Genitalmorphologie einiger *Nepticula*-Arten (Lep., Nepticulidae). – *Zeitschrift der Wiener Entomologischen Gesellschaft* 36: 4-9.
- Klimesch, J., 1958. Beiträge zur Kenntnis der Lepidopteren-Fauna der Wachau in Niederösterreich (Microlepidoptera). – *Zeitschrift der Wiener Entomologischen Gesellschaft* 43: 17-22, 43-44, 76-77, 91-97.
- Klimesch, J., 1961. Ordnung Lepidoptera. I. Teil. Pyralidina, Tortricina, Tineina, Eriocraniina und Micropterygina. – In: H. Franz (ed.). *Die Nordost-Alpen im*



Figs. 4-9. *Stigmella rolandi*, genitalia and leafmine. - 4, Capsule male genitalia, slide 2563 (Spain: Cadalso); 5, Valva, inner aspect, slide 2563; 6, Aedeagus, holotype, slide 2780; 7, Female terminal segments, dorso-lateral view, slide 2783 (Yugoslavia: Krk); 8, Bursa copulatrix, detail showing enlarged pectinations, slide 2783; 9, leaf-mine on *Rosa* sp. from type-locality, one of three mines from which holotype was reared. Scales: 0.1 mm (figs. 4-8), 5 mm (fig. 9); 4-6 and detail of 8 on same scale.

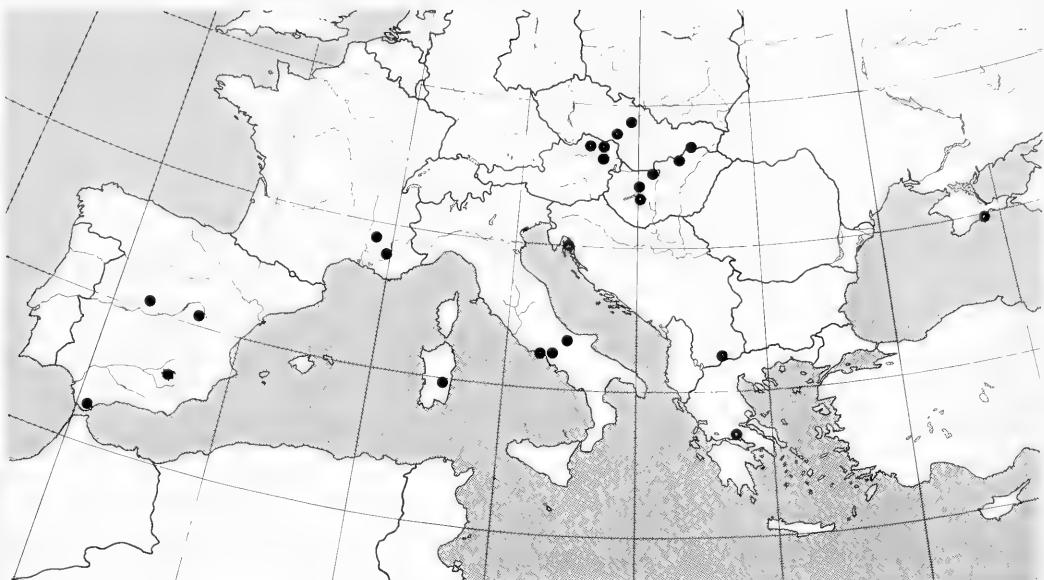


Fig. 10. Distribution of *Stigmella rolandi*, mapped on 50 × 50 km UTM squares.

Spiegel ihrer Landtierwelt, 2: 481-789. Universitätsverlag Wagner, Innsbruck.

Klimesch, J., 1978. Beitrag zur Kenntnis der Nepticulidenfauna von Anatolien und der Insel Rhodos (Lepidoptera, Nepticulidae). – Tijdschrift voor Entomologie 121: 239-278.

Nieuwerken, E. J. van, 1986. A provisional phylogenetic check-list of the western palaearctic Nepticulidae, with data on hostplants (Lepidoptera). – Entomologica Scandinavica 17:1-27.

Nieuwerken, E. J. van, 1990. The *Trifurcula subnitidella* group (Lepidoptera: Nepticulidae): taxonomy, distribution and biology. – Tijdschrift voor Entomologie 133: 000-000.

Szőcs, J., 1955. A budapesti Mártonhegy lepke-faunája. – Folia entomologica Hungarica, s. n. 8: 157-171.

Szőcs, J., 1956. Magyarország Nepticulidái (Lepidopt.) (Die in Ungarn vorkommenden Nepticula-Arten (Lepidopt.)) – Folia entomologica Hungarica, s. n. 9: 381-394.

Szőcs, J., 1963. A lepkehernyoók természetes tápnövényei. [Die natürlichen Futterpflanzen der Schmetterlingsraupen.] – Folia entomologica Hungarica, s. n. 16: 83-120.

Szőcs, J., 1965. Microlepidoptera I, Nepticulidae. – Fauna Hungarica 76: 48-104.

Szőcs, J., 1973. Adatok a Bakony aknázómoly faunájához. Angaben zur Minierfliegen-fauna [sic!] des Bakony-Gebirges. – A Veszprém megyei múzeumok Közleményei 12: 451-455.

Szőcs, J., 1977. Adatok a Mátra-Hegység Aknázómolyfaunájához. (Data to the mining moth fauna found in the Mts. Mátra.) – Folia Historia naturalis Musei Matrensis 4: 91-99.

Szőcs, J., 1978. Adatok a Pilis-hegység Aknázómoly faunájához. (Data to the mining moths fauna from the Pilis Mts.) – Folia entomologica Hungarica, s. n. 31: 265-271.

Szőcs, J., 1981. Angaben über minierenden Motten aus Budapest und Umgebung. – Folia entomologica Hungarica, s. n. 42: 209-220.

Waters, E. G. R., 1928. A new *Nepticula* from North Wales. – Entomologist's monthly Magazine 64: 105-106.

Zimmermann, F., 1944. Zur Kenntnis der Verbreitung der Nepticuliden in den Reichsgauen Wien und Niederdonau (Lepidopt.). – Zeitschrift der Wiener Entomologischen Gesellschaft 29: 3-6, 60-64, 78-91, 107-122.

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NEW TAXA OF FEATHER MITES (ACARINA, PTEROLICHIDAE) FROM MEGAPODES (AVES, MEGAPODIIDAE)

Pérez, T. M. & W. T. Atyeo, 1990. New taxa of feather mites (Acarina, Pterolichidae) from Megapodes (Aves, Megapodiidae). – Tijdschrift voor Entomologie 133: 245-249, figs. 1-10, table 1. [ISSN 0040-7496]. Published 14 December 1990.

Asctetolichus gen. n. (Pterolichoidea, Pterolichidae) is established for the type species *Pterolichus (Pseudalloptes) palmiger* Trouessart and two new species, *A. microthrix* and *A. ruidus*. All hosts are Megapodiidae.

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Key words. – Feather mites, Pterolichidae, *Asctetolichus*, Megapodiidae parasites.

In the late 1800s and early 1900s E. L. Trouessart, often in collaboration with other authors, named many taxa of feather mites taken primarily from study skins in ornithological collections in Paris and Angers. His collections included mites from three species of Megapodiidae: '... les Talégalles (*Talegallus Cuvieri* et *Aepipodius Bruijnini*) de Nouvelle-Guinée' and '... le Mégapode de Jobi (*Megapodius Jobiensis*) de île Jobi (Nouvelle-Guinée).' From these hosts, Trouessart (1887) and Trouessart & Neumann (1888) described seven mite species, however, the location of most of the types is unknown. By examining megapode study skins we have recovered the seven species of Trouessart plus many new species.

From this rich and diverse acarofauna, we will establish herein a new genus for one of seven Trouessart species and two new species.

MATERIALS AND METHODS

We have examined 54 collections of feather mites from 95 museum study skins of megapodes at the American Museum of Natural History (see Atyeo & Braasch 1966 for collecting technique). These mites are from 13 of the 19 megapode species as recognized by White & Bruce (1986). Each collection contains all mite specimens taken from an individual skin, but the specimens may include only a portion of the species known from the host species (see Méjia-González & Pérez 1988 for limitations of the collecting technique). The megapode

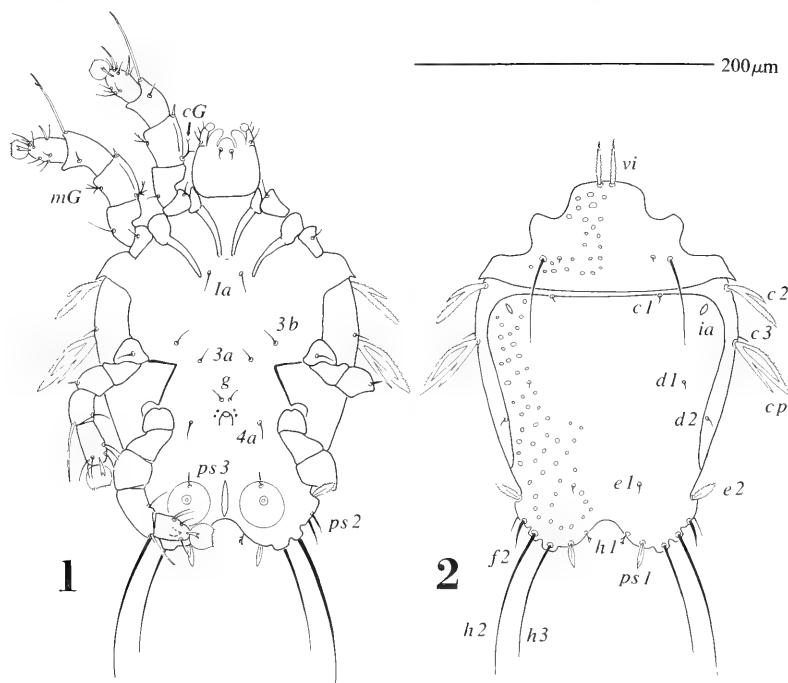
species examined followed by the number of samples taken and the number of skins examined are given in table 1. Names denoted by asterisks are hosts from which species of the new genus were collected.

All taxa being described, regardless of the sample size, are believed to be from the Megapodiidae as we have never encountered similar forms in any of our extensive collections from the birds of the world.

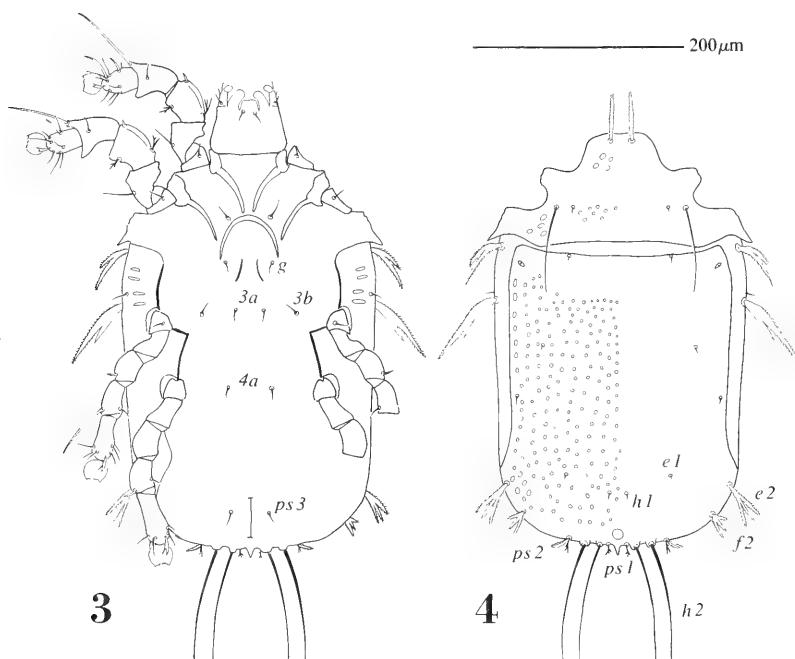
Signatures for idiosomal setae follow the Grandjean system as modified by Griffiths et al. (1990).

Table 1. The number of feather mite collections (left number) obtained from museum study skins examined (right number) of megapodes. Asterisks indicate hosts of *Asctetolichus* species.

<i>Megapodius freycinet</i> Gaimard, 1823	11 of 15
<i>M. eremita</i> Hartlaub, 1867	3 of 4
<i>M. affinis</i> A. B. Meyer, 1874 (= <i>decoloratus</i> Oustalet, 1878) (= <i>jobiensis</i> Oustalet, 1881)	1 of 3 3 of 5
<i>M. laperouse</i> Gaimard, 1823	9 of 14
<i>M. pritchardi</i> G. R. Gray, 1864 (= <i>Eulipoa wallacei</i> G. R. Gray, 1860)	0 of 10 5 of 7
<i>Leipoa ocellata ocellata</i> Gould, 1840	1 of 1
<i>L. ocellata rosinae</i> Mathews, 1912	0 of 2
<i>Alectura lathami</i> J. E. Gray, 1831*	2 of 11
<i>Talegalla cuvieri</i> Lesson, 1828	3 of 3
<i>T. jobiensis jobiensis</i> A. E. Meyer, 1874*	4 of 5
<i>T. fuscirostris</i> Salvadori, 1877	4 of 5
<i>Aepyopodius arfakianus</i> (Salvadori, 1877)*	3 of 4
<i>A. bruijnii</i> (Oustalet, 1880)*	2 of 2
<i>Macrocephalon maleo</i> S. Müller, 1846	3 of 4



Figs. 1-2. *Ascetolichus palmiger* (Trouessart). Ventral and dorsal aspects of male. Setae signatures follow Griffiths et al. (1990).



Figs. 3-4. *Ascetolichus palmiger* (Trouessart). Ventral and dorsal aspects of female. Setae signatures follow Griffiths et al. (1990).

Measurements, in micrometres, are the mean \pm standard error (when $N>10$), followed in parentheses by the observed limits and number of observations. The SEM micrographs were taken with a Philips 505 using dehydrated specimens collected from museum study skins.

Holotypes of new species will be deposited in the American Museum of Natural History. Abbreviations for other type repositories and accession numbers of bird and mite collections are: AMNH, American Museum of Natural History, New York; TRT, Trouessart Collection, Paris; and UGA, University of Georgia, Athens.

Asctolichus Pérez & Atyeo, gen. n.

Diagnosis. – Small pterolichine mites with quadrate idiosoma and gnathosoma; well-developed dorsal shields; posterolateral angles of propodosoma extended into points; all idiosomal and leg setae present; setae vi expanded, minutely branched; setae c2, cp large, branched; setae c3 minute, ventrolateral; cupules ia conspicuous; epimerites I free; legs subequal; legs III, IV ventral; pretarsi symmetrical, dentate; tarsi I and II shorter than corresponding tibiae; genua I, II, tibiae I, II with dorsal crests or pebbled surfaces; bases of solenidia σ, φ respectively elevated above tibiae, tarsi; genua I, II with setae mG bi- or trifurcate. Male idiosoma with shallow terminal cleft on which is inserted leaflike ps1 and branched h1; setae e2 ovate, fringed; adanal discs small, about 8 in diameter, edentate; tarsus IV with subterminal claw. Female with idiosoma parallel-sided, more or less truncated posteriorly; external spermiduct present; various terminal setae elaborated (as in fig. 4); oviportus and associated structures anterior of sejugal furrow.

Type species. – *Pterolichus (Pseudallopites) palmiger* Trouessart.

Etymology. – Contraction of *asketos* (Gr., curiously wrought, ornament) and *Pterolichus*, masculine line.

Asctolichus palmiger (Trouessart) comb. n. (figs. 1-6, 8)

Pterolichus (Pseudallopites) palmiger Trouessart, 1887: 116-7; Canestrini & Kramer 1899: 61.

Males. – Dorsal shields with small pits unequally distributed; genua I, II with ridges parallel to axis; genua I, II with setae mG, cG coarsely branched; setae cp long, bifurcate, unequal branches; measurements: length, including gnathosoma 279 ± 2 (262-290, 19), width 170 ± 1 (162-177, 19), sce:sce 86.5 ± 0.8 (78.4-92.1, 19), c2 length 46.2 ± 0.7 (39.2-49.0, 17), cp length 58.4 ± 0.7 (50.9-63.7, 19), h1 length 8.3 ± 0.2 (7.8-9.8, 18), ps1 19.6 ± 0.3 (17.6-

21.6, 18), gnathosomal length 45.2 ± 0.4 (43.1-49.0, 19), gnathosomal width 46.9 ± 0.3 (45.1-49.0, 17).

Females. – Proterosoma as in male; dorsal hysterosoma with small pits, especially along margins; measurements: length, including gnathosoma 435 (424-463, 7), external spermiduct about 13.7; width 230 (220-254, 7), sce:sce 120.4 (113.7-129.4, 7), c2 length 59.1 (54.9-66.6, 6), c3 length 87.1 (82.3-92.1, 6), e2 length 51.9 (50.9-54.9, 6), f2 length 22.7 (19.6-23.5, 7), ps1 14.8 (11.8-17.6, 7), ps2 23.3 (19.6-27.4, 5), gnathosomal length 65.8 (64.7-68.7, 7), gnathosomal width 69.2 (62.7-76.4, 7).

Type data. – From *Aepypodius bruijnii*: New Guinea, [Waigeu Island], lectotype ♂, paralectotype ♀ (TRT slide 37 A 1).

Material examined. – The type series (see Remarks) and other specimens from *Aepypodius bruijnii*: Indonesia: West Irian: Waigeu Island, 15 ♂, 4 ♀, circa 1894, A. A. Bruijn (AMNH 539411, UGA 5339; AMNH 539410, UGA 5340). From *A. arfakianus*: Indonesia: West Irian: Idenburg River, 6 km SW Bernhard Camp ($39^{\circ}15'E$, $3^{\circ}30'S$), 1 ♂, 3 ♀, 21 February 1939, R. Archbold (AMNH 338429, UGA 5336); Snow Mountains, 3 ♂, 1 ♀, 24 September 1910, A. S. Meek (AMNH 539393, UGA 5337). From *Talegallus cuvieri*: New Guinea: no other data, 2 ♀ (TRT slides nos. 37 A 2, 22 H 16).

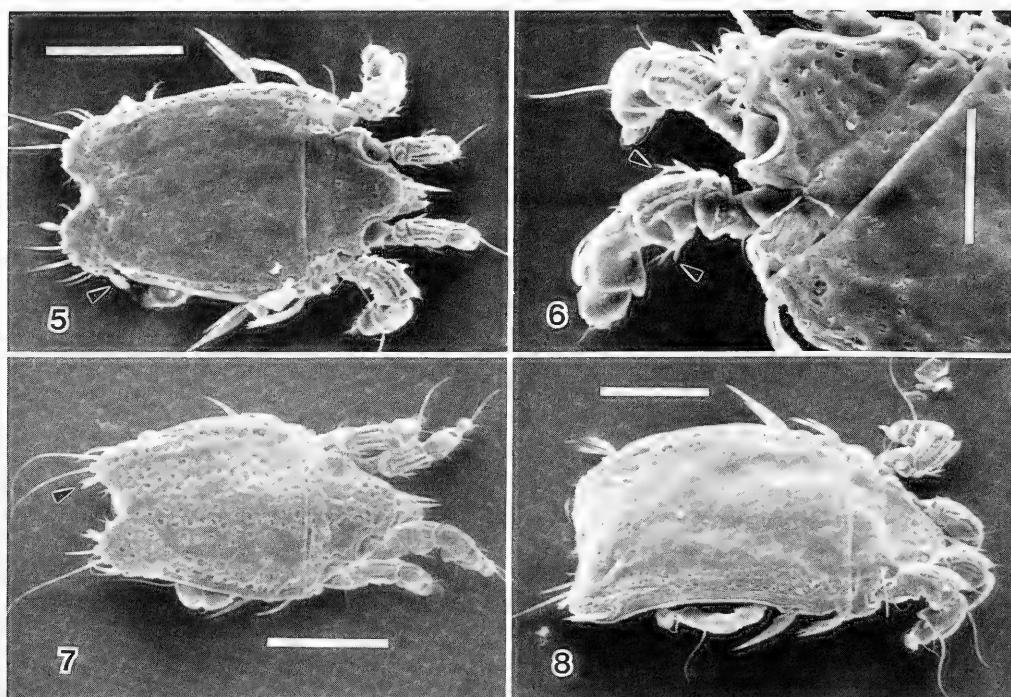
Remarks. – The number of observations for setae and gnathosomal measurements are small as many setae are lacking from the specimens and many gnathosomata have been deformed during specimen preparation. The measurements for the gnathosoma are included in this description only; they are similar for the other species for which there are few specimens.

Trouessart (1887) stated that the hosts for this species were *T. cuvieri* and *A. bruijnii*, New Guinea. Our collections from *A. bruijnii* are conspecific with Trouessart's specimens from the listed hosts (see above). We assume that Trouessart's two females from *T. cuvieri* represent accidental associations.

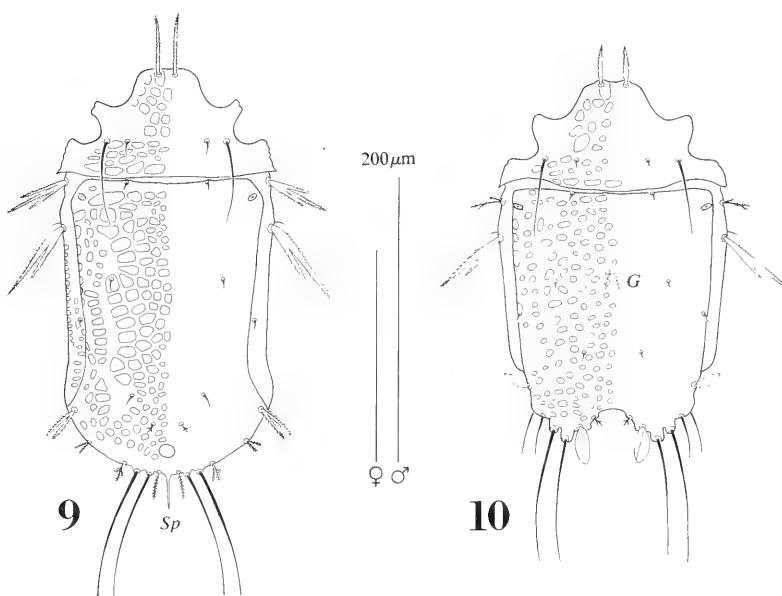
Asctolichus species (fig. 7)

One of the males used for SEM micrographs is an undescribed species (fig. 7) from the study skin of *Aepypodius arfakianus* from the Bernhard Camp (listed above). All males from the *Aepypodius* collections have been mounted and additional specimens were not found. Although the host association must be tentative until additional specimens are collected, it is possible that two species of *Asctolichus* could occur on *A. arfakianus*. Two or three congeners on a single host, with each congener occupying a different microhabitat has been well documented (Atyeo & Pérez 1988, Méjia-González & Pérez 1988).

The species is related to *Asctolichus palmiger* as



Figs. 5-8. SEMs of dorsal aspects of *Ascetolichus* species. - 5, *Ascetolichus palmiger*, male: arrow = setae e2; 6, *A. palmiger*, male propodosoma: upper arrow = setae cG, lower arrow = seta mG, genual ridges between setae; 7, *Ascetolichus* species, male: arrow = setae ps1; 8, *A. palmiger*, female. Scale bars: 5, 7, 8 = 100 µm; 6 = 50 µm.



Figs. 9-10. Dorsal aspects of *Ascetolichus* species. - 9, *A. ruidus* sp. n., female; 10, *A. microthrix* sp. n., male. G = position of male genital organ.

shown by the ridges on the anterior legs, but the dorsal ornamentation is different, setae c2 and cp are smaller, and setae ps1 are bifurcated.

Ascetolichus ruidus Pérez & Atyeo, sp. n.
(fig. 9)

Female (holotype). – Dorsal idiosoma with large, deep pits; genua I, II, femur II with antaxial surfaces pebbled; tibiae I, II with setae mG, cG thin, bi- or trifurcate; setae cp long, bifurcate, unequal branches; measurements: length, including gnathosoma 424, width 197, external spermiduct 43.1, sce:sce 111.7, c2 66.6, cp 84.3, e2 39.2, f2 19.6, ps1 23.5, ps2 157.

Male. – Unknown.

Type data. – The holotype female was collected from *Alectura lathami*: Australia: Queensland: (?) Barron River, 19 July 1884, G. M. Mathews (AMNH 539322, UGA 5324). The holotype is deposited in AMNH.

Etymology. – From *ruidus* (Gr., rough) to refer to the rugose tegument of legs I and II.

Remarks – We have only two collections from *A. lathami* and in one, the unique holotype was found. Until validated by additional material, the host association is considered tentative.

Ascetolichus microthrix Pérez and Atyeo, sp. n.
(fig. 10)

Males (N=2). – Dorsal idiosoma with large pits; legs I, II without pebbled tegument or ridges parallel to axis; genua I, II with setae mG simple or with small basal branch; setae cp bifurcate, with few branches; measurements: length, including gnathosoma 280 (278-282), width 164 (162-166), sce:sce 95.1 (94.1-96.0), c2 length 29.4 (27.4-31.4), cp length 53.9 (49.0-58.8), h1 length 11.8 (11.8), ps1 27.9 (27.4-28.4).

Female (N=1). – Proterosoma and dorsal idiosoma similar to male; measurements: length, including gnathosoma 416, width 208, sce:sce 113.7, external spermiduct 29.4, c2 31.4, cp 74.5, e2 23.5, f2, 16.7, ps1 13.7, ps2 11.8.

Type data. – From *Talegalla j. jobiensis*: Indonesia: West Irian: Humboldt Bay, Hollandia, holotype ♂, 1 ♂, 1 ♀ paratypes, 5 August 1928, E. Mayr (AMNH 539377, UGA 5332). The holotype is deposited in AMNH, paratypes in UGA.

Etymology. – From *mikros* (Gr., small) and *thrix* (Gr. seta) to refer to the small setae c2.

Remarks. – The two males in this collection had setae e2 missing; they have been represented with dotted lines as structures similar to those of *A. palmiger*.

The females of the two new species, *A. ruidus* and *A. microthrix* differ from those of *A. palmiger* by having long external spermiducts. The female of *A. ruidus* differs from *A. microthrix* in having the pits of the hysterosomal shield approximately equal in size, a longer spermiduct, and longer setae (especially c2, e2, ps1, compare measurements).

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REFERENCES

- Atyeo, W. T. & N. L. Braasch, 1966. The feather mite genus *Proctophyllodes* (Sarcoptiformes: Proctophyllodidae). – Bulletin of the University of Nebraska State Museum 5: 1-354.
- Atyeo, W. T. & T. M. Pérez, 1988. Species in the genus *Rhytidelasma* Gaud (Acarina: Pterolichidae) from the Green Conure, *Aratinga holochlora* (Slater) (Aves: Psittacidae). – Systematic Parasitology 11: 85-96.
- Canestrini, G. & P. Kramer, 1899. Demodicidae und Sarcoptidae. – Das Tierreich 7: 1-193.
- Griffiths, D. A., W. T. Atyeo, R. A. Norton & C. A. Lynch, 1990. The idiosomal chaetotaxy of astigmatid mites. – Journal of Zoology, London 220: 1-32.
- Méjia-González, E. & T. M. Pérez, 1988. Three new species of *Fainalges* Gaud and Berla (Analgoidea: Xolalgidae) with descriptions of their developmental series. – Acarologia 29: 73-86.
- Trouessart, E. L. (1886) 1887. Diagnoses d'espèces nouvelles de Sarcoptides plumicoles (Analgesinae). – Bulletin de la Société d'études scientifiques d'Angers 15: 85-156.
- Trouessart, E. L. & G. Neumann, 1888. Diagnoses d'espèces nouvelles de Sarcoptides plumicoles (Analgesinae). – Bulletin scientifique de la France et de la Belgique 19: 325-380.
- White, C. M. N. & M. D. Bruce, 1986. The birds of Wallacea. – British Ornithologists' Union Check-list No. 7, 524 p.

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THE TYPE SPECIMENS OF ENDERLEIN'S BRACONINAE (HYMENOPTERA: BRACONIDAE) HOUSED IN WARSAW

Quicke, D. L. J. & C. van Achterberg, 1990. The type specimens of Enderlein's Braconinae (Hymenoptera: Braconidae) housed in Warsaw. – Tijdschrift voor Entomologie 133: 251-264. [ISSN 0040-7496]. Published 14 December 1990.

The type specimens of 147 species of Braconinae described by Enderlein in the collection of the Polish Academy of Science, Institute of Zoology, Warsaw have been examined. Eighty-one new combinations are reported, the systematic positions of 39 species are confirmed and lectotypes are designated for 62 species. The genera *Diolcia* Enderlein and *Monolcia* Enderlein are synonymized with *Campyloneurus* Szépligeti; *Diamblomerina* Enderlein is synonymized with *Nedinoschiza* Cameron; *Diamblomera* Enderlein is removed from synonymy with *Odontoscapus* Kriechbaumer and provisionally treated as a valid genus. *Cyanopterus solox* Enderlein is treated as a new junior synonym of *Eurobracon triplagiata* Cameron.

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Key words. – Hymenoptera, Braconidae, Braconinae, Enderlein, reclassification, lectotypes.

Günter Enderlein (1905a, 1905b, 1920) described a large number of new taxa of Braconidae including 153 new species and 17 new genera of Braconinae, the vast majority being dealt with in the last of his papers. The primary types of 147 taxa are listed in this paper because they are deposited in the Instytut Zoologii of the Polish Academy of Sciences in Warsaw (PAN). Enderlein worked at the Museum für Naturkunde, Stettin (now Szczecin in north-west Poland) between the years 1906 and 1919. The principally tropical Braconidae dealt with in his papers were mainly from the collection of the former curator of the Stettin Museum, Dr. H. Dohrn and most of them were collected in Sumatra by Mr. M. Ude. The specimens in the collection formerly belonging to the Museum für Naturkunde in Berlin are duplicates retained by Enderlein. As a consequence of the Second World War, the collection finally ended up in the Polish Academy of Sciences. It is now housed at a field station/museum belonging to the PAN at Łomna, approximately 30 km north-west of Warsaw, and the main part of the material is in very good condition.

Although it had been possible to study some of this material in the past by means of small postal loans, damage that accrued to a considerable part of such loaned material due to bad postal handling has meant that Dr Eugeniusz Kierych, the curator of

entomology at the PAN, was reluctant to continue such loans. Thus in order to examine the entirety of the Enderlein collection so that the identities of many of his species could be re-assessed, the authors have recently visited the PAN facility at Łomna and the findings are reported below.

Enderlein's species concept seems to have been reasonable, although he described the same species on several occasions twice in the same paper; only rarely are his type series heterogeneous. However, his generic concept was, judging from his work on the Braconinae, very poor indeed and he would often describe two new genera based on one or two closely related species. For example, his genera *Antidiolcus* and *Plagiozina* (both of which have now been synonymized with *Nesaulax* Roman; Quicke 1984a) are based on what are in fact two sibling species. Similarly, his genera *Diolcia* and *Monolcia* are based on another extremely closely related pair of species, both of which are transferred below to *Campyloneurus* Szépligeti. On other occasions he split the members of a single genus between as many as four genera, for example, species of *Hemibracon* Szépligeti were described under *Ipobracon* Thomson, *Antiolcus* Enderlein and *Udamolx* Enderlein as well as in *Hemibracon* itself.

Enderlein's inconsistencies and the errors in the generic level classification of his braconine species

Table 1. Overview of the current taxonomic status of the Braconinae described by G. Enderlein and deposited in PAN.

Current genus	Species	Original genus	Type-locality
<i>Antiocia</i> Enderlein	<i>mitelligera</i> Enderlein, 1920: 116-117	<i>Antiocia</i>	Cameroons: Barombi
<i>Archibracon</i> Saussure	<i>atricauda</i> Enderlein, 1920: 97	<i>Udamolx</i>	S. Africa: Natal
	<i>gutta</i> Enderlein, 1920: 97-98	<i>Udamolx</i>	S. Africa: Natal
<i>Bathyaulax</i> Szépligeti	<i>flavipera</i> Enderlein, 1920: 126-127	<i>Euryacria</i>	Madagascar: Amber Mountains
	<i>gutta</i> Enderlein, 1920: 122-123	<i>Goniobracon</i>	S. Africa: Natal
	<i>laeviventris</i> Enderlein, 1920: 126	<i>Bathyaulax</i>	Madagascar: Amber Mountains
	<i>latiangulata</i> Enderlein, 1920: 125-126	<i>Bathyaulax</i>	Madagascar: Tamatave
	<i>nigriceps</i> Enderlein, 1920: 125	<i>Bathyaulax</i>	S. Africa: Transvaal: Zoutpansberg
	<i>pectinatus</i> Enderlein, 1920: 123	<i>Goniobracon</i>	S. Africa: Transvaal: Zoutpansberg
<i>Blastomorpha</i> Szépligeti	<i>ragiviventris</i> Enderlein, 1920: 124-125	<i>Bathyaulax</i>	Tanzania
<i>Campyloneurus</i> Szépligeti	<i>celebensis</i> Enderlein, 1920: 55-56	<i>Platybracon</i>	Indonesia: N. Sulawesi
	<i>angulosus</i> Enderlein, 1920: 115	<i>Monolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>basalis</i> Enderlein, 1920: 105-106	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>bicarinatus</i> Enderlein, 1920: 112	<i>Diolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>cingulicauda</i> Enderlein, 1920: 105	<i>Campyloneurus</i>	Taiwan: Taihorin
	<i>flavicosta</i> Enderlein, 1920: 115-116	<i>Monolcia</i>	Indonesia: Java: Sukabumi
	<i>impressimargo</i> Enderlein, 1920: 109	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>latiscutellum</i> Enderlein, 1920: 103	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>limbaticauda</i> Enderlein, 1920: 112	<i>Diolcia</i>	Indonesia: Java: Sukabumi
	<i>marginiventris</i> Enderlein, 1920: 109-110	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>nigricosta</i> Enderlein, 1920: 108	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>punctativentris</i> Enderlein, 1920: 110	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>reticulatus</i> Enderlein, 1920: 107	<i>Campyloneurus</i>	Ceylon
	<i>serenans</i> Enderlein, 1920: 104-105	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>speculiger</i> Enderlein, 1920: 109	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>tibialis</i> Enderlein, 1920: 108	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>tricarinatus</i> Enderlein, 1920: 113	<i>Monolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>trispeculatus</i> Enderlein, 1920: 107-108	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
<i>Chaoilta</i> Cameron	<i>carinicornis</i> Enderlein, 1920: 55	<i>Platybracon</i>	Indonesia: Sumatra: Sukaranda
	<i>compta</i> Enderlein, 1920: 56	<i>Platybracon</i>	Indonesia: Sumatra: Liangagas
<i>Chelonogastra</i> Ashmead	<i>disciventris</i> Enderlein, 1920: 103	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
<i>Compsobracon</i> Ashmead	<i>thodeanus</i> Enderlein, 1920: 57	<i>Cyanopterus</i>	Brazil: Santa Catharina
<i>Cordibracon</i> van Achterb.	<i>laqueatus</i> Enderlein, 1920: 120	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
<i>Craspedolcus</i> Enderlein	<i>fraternus</i> Enderlein, 1920: 92	<i>Craspedolcus</i>	Indonesia: Sumatra: Sukaranda
	<i>maculicosta</i> Enderlein, 1920: 71-72	<i>Ipobracon</i>	Indonesia: Java: Sukabumi
	<i>obscuriventris</i> Enderlein, 1920: 93	<i>Craspedolcus</i>	Indonesia: Sumatra: Sukaranda
	<i>trisulcatus</i> Enderlein, 1920: 92	<i>Craspedolcus</i>	Indonesia: Sumatra: Sukaranda
	<i>gibber</i> Enderlein, 1920: 65-66	<i>Merrnotus</i>	Indonesia: Sumatra: Sukaranda
	<i>grata</i> Enderlein, 1920: 117	<i>Antiocia</i>	Tanzania: Nyembe Bulungwa
	<i>gratiosus</i> Enderlein, 1920: 53	<i>Aphrastobracon</i>	Bioka (= Fernando Poo)
	<i>guttifer</i> Enderlein, 1920: 53	<i>Aphrastobracon</i>	Cameroons: Barombi
	<i>acuticellus</i> Enderlein, 1920: 100-101	<i>Diamblomera</i>	Indonesia: Sumatra: Sukaranda
	<i>grisescens</i> Enderlein, 1920: 101	<i>Diamblomera</i>	Indonesia: Sumatra: Sukaranda
<i>Diamblomera</i> Enderlein	<i>acuticampa</i> Enderlein, 1920: 86	<i>Ipobracon</i>	Colombia: Rio Magdalena
	<i>aloniger</i> Enderlein, 1920: 78	<i>Ipobracon</i>	Colombia
	<i>aterimma</i> Enderlein, 1920: 98	<i>Udamolx</i>	Brazil
	<i>aureopilosa</i> Enderlein, 1920: 80	<i>Ipobracon</i>	Brazil: Obodos
	<i>bareata</i> Enderlein, 1920: 92	<i>Ipobracon</i>	Peru
	<i>bicristata</i> Enderlein, 1920: 88	<i>Ipobracon</i>	Colombia
	<i>bicuneata</i> Enderlein, 1920: 87-88	<i>Ipobracon</i>	Brazil: Obidos
	<i>bicunea</i> Enderlein, 1920: 83-84	<i>Ipobracon</i>	Ecuador: Curaray
	<i>brevicapula</i> Enderlein, 1920: 91	<i>Ipobracon</i>	Guyana: Demerara
	<i>brevicunea</i> Enderlein, 1920: 78-79	<i>Ipobracon</i>	Peru: Chanchamayo: Rio Tora
	<i>cameroni</i> Enderlein, 1920: 82	<i>Ipobracon</i>	Mexico: Chiapas
	<i>chilensis</i> Enderlein, 1920: 58	<i>Cyanopterus</i>	Chile
	<i>columbiiana</i> Enderlein, 1920: 82	<i>Ipobracon</i>	Colombia
	<i>crenulata</i> Enderlein, 1920: 79	<i>Ipobracon</i>	Brazil (? Guyana): Demerara
	<i>digitata</i> Enderlein, 1920: 84	<i>Ipobracon</i>	Brazil: Santa Catharina
	<i>duplicata</i> Enderlein, 1920: 82-83	<i>Ipobracon</i>	Brazil: Santa Catharina
	<i>ecuadorensis</i> Enderlein, 1920: 85	<i>Ipobracon</i>	Ecuador: Balzapampa
	<i>fenestrata</i> Enderlein, 1920: 89	<i>Ipobracon</i>	Brazil: Pebas

Table 1. (continued).

Current genus	Species	Original genus	Type-locality
	<i>flavicaligata</i> Enderlein, 1920: 80	<i>Ipobracon</i>	Guyana; Demarara
	<i>latecrenulata</i> Enderlein, 1920: 81-82	<i>Ipobracon</i>	Brazil: Santa Catharina
	<i>latefasciata</i> Enderlein, 1920: 90	<i>Ipobracon</i>	Brazil: Obidos
	<i>laticampa</i> Enderlein, 1920: 90-91	<i>Ipobracon</i>	Guyana: Demerara
	<i>laticunea</i> Enderlein, 1920: 79	<i>Ipobracon</i>	Peru: Chanchamayo: Rio Toro
	<i>longicapula</i> Enderlein, 1920: 91	<i>Ipobracon</i>	Guyana: Demerara
	<i>macella</i> Enderlein, 1920: 86	<i>Ipobracon</i>	Peru: Chanchamayo
	<i>mediofusca</i> Enderlein, 1920: 88-89	<i>Ipobracon</i>	Brazil: Obidos
	<i>nigripecta</i> Enderlein, 1920: 83	<i>Ipobracon</i>	Argentine: Mendoza
	<i>obtusicampa</i> Enderlein, 1920: 85-86	<i>Ipobracon</i>	Colombia
	<i>ochriptera</i> Enderlein, 1920: 86-87	<i>Ipobracon</i>	Ecuador: Guayaquil
	<i>penniseteta</i> Enderlein, 1920: 87	<i>Ipobracon</i>	Brazil: Obidos
	<i>rectivena</i> Enderlein, 1920: 81	<i>Ipobracon</i>	Brazil: Santa Catharina
	<i>sigillata</i> Enderlein, 1920: 79	<i>Ipobracon</i>	Peru
	<i>speculata</i> Enderlein, 1920: 89-90	<i>Ipobracon</i>	Colombia: Rio Magdalena
	<i>subfracta</i> Enderlein, 1920: 96-97	<i>Antioclus</i>	Brazil: Obidos
	<i>tuberculata</i> Enderlein, 1920: 84-85	<i>Ipobracon</i>	Peru: Chanchamayo: Rio Toro
	<i>peruliventris</i> Enderlein, 1920: 110-111	<i>Ectemnoplax</i>	Taiwan: Takao
<i>Ectemnoplax</i> Enderlein	<i>merinotoides</i> Enderlein, 1920: 128-129	<i>Braccon</i>	Indonesia: Sumatra: Sukaranda
<i>Eurobracon</i> Ashmead	<i>solox</i> Enderlein, 1920: 58	<i>Cyanopterus</i>	India: Sikkim
<i>Gammabracon</i> Quicke	<i>nigriseta</i> Enderlein, 1920: 68-69	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
<i>Gronaulax</i> Cameron	<i>laticampus</i> Enderlein, 1920: 69	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
<i>Hemibracon</i> Szépligeti	<i>apicalis</i> Enderlein, 1920: 96	<i>Antioclus</i>	Costa Rica
	<i>catharinensis</i> Enderlein, 1920: 98-99	<i>Udamolx</i>	Brazil: Santa Catharina
	<i>crasscrenulatus</i> Enderlein, 1920: 81	<i>Ipobracon</i>	Brazil: Santa Catharina
	<i>nigripalpis</i> Enderlein, 1920: 90	<i>Ipobracon</i>	Ecuador: Balzapamba
	<i>politus</i> Enderlein, 1920: 99	<i>Udamolx</i>	Peru: Chanchamayo
	<i>vau cristatus</i> Enderlein, 1920: 99-100	<i>Udamolx</i>	Guyana: Demerara
	<i>w-impressus</i> Enderlein, 1920: 63	<i>Hemibracon</i>	Brazil: Sao Paulo de Olivencia
	<i>crista</i> Enderlein, 1920: 75-76	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>brevisetosa</i> Enderlein, 1920: 60	<i>Megagonia</i>	Indonesia: Sumatra: Sumba
	<i>sauteri</i> Enderlein, 1920: 128	<i>Iphiaulax</i>	Taiwan: Takao
	<i>udei</i> Enderlein, 1920: 127-128	<i>Iphiaulax</i>	Indonesia: Sumatra: Sukaranda
	<i>rhyssides</i> Enderlein, 1920: 61-62	<i>Rhadinobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>quadrirugulosus</i> Enderlein, 1920: 94	<i>Craspedolcus</i>	Ecuador: Bucay
	<i>filiseta</i> Enderlein, 1920: 57-58	<i>Cyanopterus</i>	Peru: Chanchamayo: Rio Toro
	<i>lurida</i> Enderlein, 1920: 111	<i>Ectemnoplax</i>	S. Africa
	<i>speciosus</i> Enderlein, 1920: 121-122	<i>Diamblomerina</i>	Indonesia: Sumatra: Sukaranda
	<i>excisus</i> Enderlein, 1920: 95-96	<i>Antidiolcus</i>	Indonesia: Sumatra: Sukaranda
	<i>gracilis</i> Enderlein, 1920: 67-68	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>pravivena</i> Enderlein, 1920: 94-95	<i>Plagiozina</i>	Indonesia: Sumatra: Sukaranda
	<i>albescens</i> Enderlein, 1920: 117-118	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>albicans</i> Enderlein, 1920: 102-103	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>apicalis</i> Enderlein, 1920: 114	<i>Monoclia</i>	Indonesia: Sumatra: Sukaranda
	<i>gibbiventris</i> Enderlein, 1920: 104	<i>Campyloneurus</i>	India
	<i>insolita</i> Enderlein, 1920: 118	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>sumatrana</i> Enderlein, 1905b: 236	<i>Gastrotroeca</i>	Indonesia: Sumatra: Sukaranda
	<i>magnificus</i> Enderlein, 1920: 77-78	<i>Ipobracon</i>	Tanzania: Usambara: Bulwa
	<i>cincticauda</i> Enderlein, 1920: 104	<i>Campyloneurus</i>	Indonesia: Sumatra: Liangagas
	<i>ruficauda</i> Enderlein, 1920: 71	<i>Meronotus</i>	Namibia
	<i>capillicauda</i> Enderlein, 1905a: 196	<i>Rhamnura</i>	Togo: Bismarckburg
	<i>filicauda</i> Enderlein, 1905a: 195	<i>Rhamnura</i>	Cameroons: Joh.-Albrechtshöhe
	<i>denticornis</i> Enderlein, 1920: 123	<i>Goniobracon</i>	Cameroons: Kribi
	<i>bispeculum</i> Enderlein, 1920: 69	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>criniseta</i> Enderlein, 1920: 68	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>flagriseta</i> Enderlein, 1920: 64-65	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>ingentiseta</i> Enderlein, 1920: 70-71	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>quadricarinata</i> Enderlein, 1920: 66-67	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>rimicunea</i> Enderlein, 1920: 67	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>rugiventris</i> Enderlein, 1920: 77	<i>Ipobracon</i>	Indonesia: Java: Sukabumi
	<i>elegantulus</i> Enderlein, 1920: 62-63	<i>Hemibracon</i>	Indonesia: Sumatra: Sukaranda
	<i>pusillus</i> Enderlein, 1920: 121	<i>Syntomernus</i>	Taiwan: Takao
	<i>tridentata</i> Enderlein, 1920: 60-61	<i>Odontopygia</i>	Indonesia: Sumatra: Sukaranda
	<i>sannio</i> Enderlein, 1920: 54	<i>Pseudospinaria</i>	Indonesia: Sumatra: Sukaranda

Table 1. (continued).

Current genus	Species	Original genus	Type-locality
<i>Undabracon</i> Quicke	<i>jucundus</i> Enderlein, 1920: 119	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
<i>Zaglyptogastra</i> Ashmead	<i>griseiseta</i> Enderlein, 1920: 59	<i>Megagonia</i>	Indonesia: Sumatra: Sukaranda
	<i>helvimacula</i> Enderlein, 1920: 123-124	<i>Goniobracon</i>	Ethiopia: Eritrea: Asmara
	<i>plumiseta</i> Enderlein, 1920: 59-60	<i>Megagonia</i>	Indonesia: Sumatra: Sukaranda
Unplaced species (these taxa will be treated in a forthcoming paper by the junior author)			
	<i>albimanus</i> Enderlein, 1920: 118-119	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>angustisulca</i> Enderlein, 1920: 73-74	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>basispeculum</i> Enderlein, 1920: 73	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>consimilis</i> Enderlein, 1920: 113-114	<i>Monolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>denticornis</i> Enderlein, 1920: 120-121	<i>Udamolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>flavimarginatus</i> Enderlein, 1920: 114	<i>Monolcia</i>	Indonesia: Java: Sukabumi
	<i>gracilis</i> Enderlein, 1920: 118	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>laevibasis</i> Enderlein, 1920: 75	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>laeviventris</i> Enderlein, 1920: 76-77	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>latisulca</i> Enderlein, 1920: 74	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>maculistigma</i> Enderlein, 1920: 107	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda
	<i>parvispeculum</i> Enderlein, 1920: 73	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>serenimanus</i> Enderlein, 1920: 114-115	<i>Monolcia</i>	Indonesia: Sumatra: Sukaranda
	<i>sexrugosus</i> Enderlein, 1920: 72-73	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>strigidorsum</i> Enderlein, 1920: 93	<i>Craspedolcus</i>	Indonesia: Sumatra: Sukaranda
	<i>trirugosus</i> Enderlein, 1920: 72	<i>Ipobracon</i>	Indonesia: Sumatra: Sukaranda
	<i>trispeculum</i> Enderlein, 1920: 70	<i>Merinotus</i>	Indonesia: Sumatra: Sukaranda
	<i>undicuneus</i> Enderlein, 1920: 106-107	<i>Campyloneurus</i>	Indonesia: Sumatra: Sukaranda

1. Including *Udamolcia* Enderlein, 1920; the group is currently being revised by the junior author.

are almost entirely attributable to his giving an inordinate amount of weight to the number of metasomal tergites that have transverse sub-posterior grooves. Only rarely does this character have any significance at the genus level in the Braconinae, but Enderlein based several of his new genera solely on its distribution. It is perhaps not too surprising therefore that only a few of his genera have stood the test of time.

ANNOTATED CATALOGUE

The following is a list of all the species of Braconinae described by Enderlein (1905a, 1905b, 1920) whose types are in the PAN collection. Nearly all of these species were described in Enderlein's 1920 paper, however, the five species of *Rhamnura* Enderlein were described in Enderlein (1905a) and one species of *Gastrotheca* Guérin-Méneville (not Fitzinger) (= *Physaraia* Shenefelt) were described in Enderlein (1905b). The type specimens of all of these are in the PAN except for those of three of the species of *Rhamnura* and paralectotypes of the remaining two, which are in the Berlin Museum.

Enderlein's original publications generally give considerable detail concerning the type series and the type localities. Where the type series includes members of only one sex he usually placed a 'Typus' label on one individual and 'Co-Typus' labels on the

remainder thus giving a clear indication of which specimen he wished the species concept to be based upon; in nearly all such cases we have selected his specimen bearing the 'Type' label as lectotype. However, where the type series contains both males and females he usually placed a 'Type' label on one female and on one male; in these cases we have generally selected the female as the lectotype as this is the sex upon which most species descriptions in the Braconidae are based. Because of Enderlein's detailed notes on the type material, only a summary is provided below; the type locality of the primary types is given in table 1. It should be noted that Shenefelt (1978) also gives some type locality details corresponding to that of the holotype or those specimens bearing 'Type' labels.

The species are listed below under their original generic combinations in alphabetical order. Where appropriate, notes are provided on the conditions of the specimens, homogeneity of the type series and previous taxonomic changes. The correct generic placement of most of the species studied is given after the heading 'Identity'; however, for some it has not been possible to make a definitive statement about their generic placement and in these cases a few notes are usually given indicating possible affinities. Their placement will be discussed in a forthcoming paper on the Indo-Australasian genera of Braconinae by the junior author.

Antidiolcus excisus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype not found, but should be present according to the original description.

Notes. – This is the type species of *Antidiolcus* Enderlein which was synonymized with *Nesaulax* Roman by Quicke (1984a).

Identity. – *Nesaulax excisus*: Quicke (1984a).

Antiolcia grata

Type material. – Female holotype.

Notes. – On Enderlein's type label this is labelled as '*Antiolcus gratus*'.

Identity. – *Curriea grata* comb. nov.

Antiolcia mitelligera

Type material. – One female with 'Type' label hereby designated as lectotype and so labelled; one male paralectotype also with 'Type' label.

Notes. – This is the type species of *Antiolcia* Enderlein which was synonymized with *Odontoscapus* Kriechbaumer by Quicke (1981). Because this taxon is aberrant in *Odontoscapus* it seems best to retain it in *Antiolcia* till its position will be discussed in the forthcoming paper by the junior author. Both specimens are rather badly eaten-out but the male is more badly damaged than the female. The specimens are labelled by Enderlein as '*Antiolcus mitelliger*'.

Identity. – *Antiolcia mitelligera*: Quicke (1981).

Antiolcus apicalis

Type material. – Female holotype.

Notes. – This is the type species of *Antiolcus* Enderlein which was synonymized with *Hemobracon* Szépligeti by Quicke (1989c).

Identity. – *Hemobracon apicalis*: Quicke (1989c).

Antiolcus subfractus

Type material. – Female holotype.

Identity. – *Digonogastra subfracta* comb. nov.

Aphrastobracon gratiosus

Type material. – Male holotype.

Notes. – Placed by Enderlein in the Aphrastobraconinae which is now considered to be a tribe of Braconinae.

Identity. – *Curriea gratiosa* comb. nov.

Aphrastobracon guttifer

Type material. – Male holotype.

Notes. – See *A. gratiosus* (above).

Identity. – *Curriea guttifer* comb. nov.

Bathyaulax laeviventris

Type material. – Female holotype.

Identity. – *Bathyaulax laeviventris*.

Bathyaulax latiangulata

Type material. – Female holotype.

Notes. – The generic identity of this species is hereby confirmed but no opinion is being given concerning the validity or otherwise of the specific synonymy proposed by Granger (1949).

Identity. – *Bathyaulax foveiventris* (Roman) (synonymized by Granger, 1949).

Bathyaulax nigriceps

Type material. – Male holotype.

Identity. – *Bathyaulax nigriceps*.

Bathyaulax rugiventris

Type material. – Male holotype.

Identity. – *Bathyaulax rugiventris*.

Bracon merinotoides

Type material. – Female holotype.

Notes. – This species was transferred to *Eurobracon* Ashmead by Fahringer (1927) and subsequently synonymized with *E. forticornis* (Cameron) by Quicke (1989b).

Identity. – *Eurobracon forticornis* (Cameron).

Campyloneurus albicans

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 'male' paralectotype with 'Typus' label; 2 female and 2 male paralectotypes with 'Co-Typus' labels.

Notes. – The specimen labelled by Enderlein as a male and bearing a 'Typus' label is in fact a female.

Identity. – Belongs to the *Pachybracon* Cameron-group.

Campyloneurus basalis Enderlein (not Szépligeti)

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 11 female paralectotypes with 'Co-Typus' labels.

Identity. – *Campyloneurus enderleini* Fahringer, 1931; replacement name.

Campyloneurus cincticauda

Type material. – Female holotype.

Identity. – *Plesiobracon cincticauda* comb. nov.

Campyloneurus cingulicauda

Type material. – Female holotype.

Identity. – *Campyloneurus cingulicauda*.

Campyloneurus disciventris

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 2 female and 6 male paralectotypes with 'Co-Typus' labels.

Identity. – *Chelonogastra disciventris* comb. nov.

Campyloneurus gibbiventris

Type material. – Female holotype.

Identity. – Belongs to the *Pachybracon* Cameron-group.

Campyloneurus impressimargo

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 female paralectotype 'Co-Typus' label.

Identity. – *Campyloneurus impressimargo*.

Campyloneurus latispeculum

Type material. – Female holotype.

Identity. – *Campyloneurus latispeculum*.

Campyloneurus maculistigma

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 female paralectotype 'Co-Typus' label, and belonging to *Chaoita*.

Identity. – Uncertain.

Campyloneurus marginiventris

Type material. – Female holotype.

Identity. – *Campyloneurus marginiventris*.

Campyloneurus nigricosta

Type material. – One female with 'Co-Typus' label hereby designated as lectotype; 3 female paralectotypes with 'Co-Typus' labels and conspecific, agreeing well with the original description. One female has the basal half of the pterostigma yellow and is not conspecific. Because this character was not indicated in the original description this specimen cannot be the lectotype, despite its 'Typus' label.

Identity. – *Campyloneurus nigricosta*.

Campyloneurus punctativentris

Type material. – Male holotype.

Identity. – *Campyloneurus punctativentris*; a provisional identification because it is a male.

Campyloneurus reticulatus

Type material. – Female holotype.

Identity. – *Campyloneurus reticulatus*

Campyloneurus serenans

Type material. – Female holotype.

Notes. – The location of the type is not indicated by Shenefelt (1978); it is in the PAN collection.

Identity. – *Campyloneurus serenans*.

Campyloneurus speculiger

Type material. – One female with 'Type' label hereby designated as lectotype; 4 female paralectotypes with 'Co-Typus' labels.

Identity. – *Campyloneurus speculiger*.

Campyloneurus tibialis

Type material. – One female with 'Type' label hereby designated as lectotype; 2 female paralectotypes with 'Co-Typus' labels.

Identity. – *Campyloneurus tibialis*.

Campyloneurus trispeculatus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 male paralectotype with 'Type' label; 1 female paralectotype with 'Co-Typus' label.

Identity. – *Campyloneurus trispeculatus*.

Campyloneurus undicuneus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 male paralectotype with 'Type' label; 14 female and 5 male paralectotypes with 'Co-Typus' labels.

Identity. – Uncertain.

Craspedolcus fraternus

Type material. – One female with 'Co-Typus' label hereby designated as lectotype; 1 female paralectotype with 'Type' label. The lectotype is not conspecific with the paralectotype and is the only specimen agreeing with the original description ('1. Tergit poliert glatt'). The paralectotype belongs to *Craspedolcus trisulcatus*.

Identity. – *Craspedolcus fraternus*.

Craspedolcus obscuriventris

Type material. – One female with 'Type' label hereby designated as lectotype; 1 male paralectotype with 'Type' label and one of the other males from Sukaranda must be also a paralectotype. The other 3 are obviously added later.

Identity. – *Craspedolcus obscuriventris*.

Craspedolcus quadrirugulosus

Type material. – Female holotype.

Identity. – *Isomecus quadrirugulosus* comb. nov.

Craspedolcus strigidorsum

Type material. – Female holotype.

Identity. – Uncertain.

Craspedolcus trisulcatus

Type material. – One female with 'Type' label is missing the ovipositor sheath, both left wings and the right fore wing. Therefore we select and hereby designate the other specimen with 'Co-Typus' label as lectotype. One female paralectotype with 'Type' label. Enderlein indicated in his description that he had a larger and a smaller specimen, so his statement at the end of the description that he had only one female is obviously false.

Identity. – *Craspedolcus trisulcatus*.

Cyanopterus chilensis

Type material. – Male holotype.

Notes. – The holotype has the head severely damaged, making its generic placement less certain at present.

Identity. – *Digonogastra chilensis*; provisional identification.

Cyanopterus filiseta

Type material. – Female holotype.

Identity. – *Megabracon filiseta* comb. nov.

Cyanopterus solox

Type material. – Female holotype.

Notes. – This species was not mentioned in the recent revision of *Eurobracon* Ashmead by Quicke (1989b).

Identity. – *Eurobracon triplagiata* (Cameron) syn. nov.

Cyanopterus thodeanus

Type material. – Female holotype.

Identity. – *Compsobracon thodeanus* comb. nov.

Diamblomera acuticella

Type material. – Female holotype.

Notes. – This is the type species of *Diamblomera* Enderlein which was synonymised with *Odontoscapus* Kriechbaumer by Quicke (1981); however, we now consider the two genera not to be synonymous and therefore we treat *Diamblomera* provisionally as a valid genus.

Identity. – *Diamblomera acuticella*.

Diamblomera grisescens

Type material. – Female holotype.

Identity. – *Diamblomera grisescens*.

Diamblomerina speciosa

Type material. – One female with 'Type' label hereby designated as lectotype; 2 female paralectotypes with 'Co-Typus' labels.

Notes. – This is the type species of *Diamblomerina* Enderlein which is treated here as a new junior synonym of *Nedinoschiza* Cameron.

Identity. – *Nedinoschiza speciosa* comb. nov.

Diolcia bicarinata

Type material. – One female with 'Type' label hereby designated as lectotype; 4 female paralectotypes with 'Co-Typus' labels.

Notes. – This is the type species of *Diolcia* Enderlein which is treated here as a new junior synonym of *Campyloneurus* Szépligeti.

Identity. – *Campyloneurus bicarinatus* comb. nov.

Diolcia limbaticauda

Type material. – Female holotype.

Identity. – *Campyloneurus limbaticauda* comb. nov.

Ectemnoplax peruliventris

Type material. – Female lectotype (hereby designated; previously selected and labelled by C. van Achterberg); 1 male paralectotype and a long series of paralectotypes labelled as 'Co-Typus' by Enderlein.

Identity. – *Ectemnoplax peruliventris*.

Ectemnoplax lurida

Type material. – Female holotype.

Identity. – *Monocoila lurida* comb. nov.

Euryacria flavipera

Type material. – Female holotype.

Notes. – This is the type species of *Euryacria* Enderlein which was synonymized with *Bathyaulax* Szépligeti by Quicke (1981).

Identity. – *Bathyaulax flavipera*: Quicke (1981).

Gastrotheca sumatrana

Type material. – One female with 'Type' label hereby designated as lectotype; the female paralectotype is missing.

Notes. – Only the lectotype was examined by Donaldson (1989).

Identity. – *Physaraia sumatrana*: Shenefelt (1978).

Goniobracon denticornis

Type material. – Holotype female.

Identity. – *Serraularia denticornis* comb. nov.

Goniobracon gutta

Type material. – Female lectotype (designated by Shenefelt 1978: 1684); 1 male paralectotype.

Notes. – *Goniobracon* Szépligeti is a junior synonym of *Bathyaulax* Szépligeti (see Quicke 1981); however, so many mistakes in the interpretation of these genera have occurred in the past that it is considered best to reclassify all species separately.

Identity. – *Bathyaulax gutta* comb. nov.

Goniobracon helvimacula

Type material. – Male holotype.

Identity. – *Zaglyptogastra helvimacula* comb. nov.

Goniobracon pectinatus

Type material. – Female holotype.

Identity. – *Bathyaulax pectinatus* comb. nov.

Hemibracon elegantulus

Type material. – One female from Sumatra with 'Typus' label hereby designated as lectotype; 10 male and 6 female paralectotypes are in PAN and additional paralectotypes from Taiwan are in the Deutsche Entomologisches Institut at Eberswalde.

Notes. – All the specimens in the type series appear to be conspecific with one another. The generic placement of this species is hereby confirmed but no statement is being made concerning its synonymy with *Stenobracon trifasciatus* Szépligeti, 1908 as proposed by Watanabe (1932) and through that, with *S. nicevillei* (Bingham, 1901).

Identity. – *Stenobracon nicevillei* (Bingham).

Hemibracon w-impressum

Type material. – Female holotype.

Identity. – *Hemibracon w-impressum*.

Iphiaulax sauteri

Type material. – Female lectotype with 'Type' label hereby designated; 1 female and 4 males paralectotypes with only lectotype label.

Identity. – *Iphiaulax sauteri*.

Iphiaulax udei

Type material. – Female holotype.

Identity. – *Iphiaulax udei*.

Ipobracon acuticampus

Type material. – Female holotype; the head, the major part of the mesosoma and part of the metasoma (including the ovipositor) missing because of damage by dermestids.

Identity. – *Digonogastra acuticampa* comb. nov.

Ipobracon alboniger

Type material. – Female holotype.

Identity. – *Digonogastra alboniger* comb. nov.

Ipobracon angustisulca

Type material. – One female with 'Type' label hereby designated as lectotype; 15 female paralectotypes with 'Co-Typus' labels.

Identity. – Uncertain, close to *I. laevibasis* Enderlein (q.v.).

Ipobracon aureopilosus

Type material. – Female holotype.

Identity. – *Digonogastra aureopilosa* comb. nov.

Ipobracon basispeculum

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Notes. – Probably conspecific with *I. sexrugosus* Enderlein (see below).

Identity. – Uncertain.

Ipobracon biareatus

Type material. – One female from Peru with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label is not conspecific.

Identity. – *Digonogastra biareata* comb. nov.

Ipobracon bicristatus

Type material. – Female holotype.

Identity. – *Digonogastra bicristata* comb. nov.

Ipobracon bicuneatus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype without 'Co-Typus' label.

Identity. – *Digonogastra bicuneata* comb. nov.

Ipobracon bicuneus

Type material. – Female holotype.

Identity. – *Digonogastra bicunea* comb. nov.

Ipobracon brevicapulus

Type material. – Female holotype.

Identity. – *Digonogastra brevicapula* comb. nov.

Ipobracon brevicuneus

Type material. – One female with 'Type' label hereby designated as lectotype; 3 female paralectotypes with 'Co-Typus' labels and a further three females without 'Co-Typus' labels but clearly included in the type series by Enderlein (1920).

Identity. – *Digonogastra brevicunea* comb. nov.

Ipobracon cameroni

Type material. – Female holotype.

Identity. – *Digonogastra cameroni* comb. nov.

Ipobracon columbianus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Identity. – *Digonogastra columbiana* comb. nov.

Ipobracon crasscrenulatus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Identity. – *Hemibracon crasscrenulatus* comb. nov.

Ipobracon crenulatus Enderlein (not Szépligeti)

Type material. – Female holotype.

Notes. – Given the replacement name *crenulatus* by Shenefelt (1978: 1814).

Identity. – *Digonogastra crenulatoria* (Shenefelt) comb. nov.

Ipobracon crista

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 38 female and 14 male paralectotypes with 'Co-Typus' labels.

Identity. – *Hybogaster crista* comb. nov.

Ipobracon digitatus

Type material. – Female holotype.

Identity. – *Digonogastra digitata* comb. nov.

Ipobracon duploareatus

Type material. – Female holotype.

Identity. – *Digonogastra duploareata* comb. nov.

Ipobracon ecuadorensis

Type material. – Female holotype.

Identity. – *Digonogastra ecuadorensis* comb. nov.

Ipobracon fenestratus

Type material. – Female holotype.

Identity. – *Digonogastra fenestrata* comb. nov.

Ipobracon flavigaligatus

Type material. – Female holotype.

Identity. – *Digonogastra flavigaligata* comb. nov.

Ipobracon laevibasis

Type material. – Female holotype.

Notes. – Appears to be closest to *Digonogastra* Ashmead but may warrant placement in a separate genus when that group is revised.

Identity. – Uncertain.

Ipobracon laeviventris

Type material. – Female holotype.

Notes. – The head is missing and therefore we cannot be certain about the generic placement of this species at present.

Identity. – Uncertain.

Ipobracon latecrenulatus

Type material. – Female holotype.

Identity. – *Digonogastra latecrenulata* comb. nov.

Ipobracon latefasciatus

Type material. – Female holotype.

Identity. – *Digonogastra latefasciata* comb. nov.

Ipobracon laticampus

Type material. – Female holotype.

Identity. – *Digonogastra laticampa* comb. nov.

Ipobracon laticuneus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Identity. – *Digonogastra laticunea* comb. nov.

Ipobracon latisulca

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 49 female and 3 male paralectotypes with 'Co-Typus' labels.

Identity. – Uncertain, probably close to *Craspedolcus* Enderlein.

Ipobracon longicapulus

Type material. – Female holotype.

Identity. – *Digonogastra longicapula* comb. nov.

Ipobracon macellus

Type material. – Male holotype.

Identity. – *Digonogastra macella* comb. nov.

Ipobracon maculicosta

Type material. – One female from Java with 'Type' label hereby designated as lectotype and has been so labelled; 1 male paralectotype also with 'Type' label; 5 female and 9 male paralectotypes with 'Co-Typus' labels.

Notes. – The male with the 'Type' label may not be conspecific with the lectotype female because it has forewing vein cu-a more or less interstitial, hindwing vein 1r-m shorter than vein SC+R1 and a posteriorly simple propodeum. The lectotype belongs to the *Craspedolcus* group having the posterior margin of the propodeum 'pinched-up' in the middle and forewing vein cu-a distinctly postfurcal (see Quicke 1984b).

Identity. – *Craspedolcus maculicosta* comb. nov.

Ipobracon magnificus

Type material. – Female holotype.

Notes. – Transferred to *Lasiophorus* by Fahringer (1931); however, *Plaxopsis*, the genus to which it belongs, is distinct from *Lasiophorus* despite the fact that both have a strong facial protuberance (van Achterberg 1983).

Identity. – *Plaxopsis magnificus* comb. nov.

Ipobracon mediofuscus

Type material. – Female holotype.

Identity. – *Digonogastra mediofusca* comb. nov.

Ipobracon nigripalpalis

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Notes. – This species was transferred to *Atanycolus* Foerster by Shenefelt (1978); *Hemobracon* Szépligeti is closely related to *Atanycolus*.

Identity. – *Hemobracon nigripalpalis* comb. nov.

Ipobracon nigripectus

Type material. – One female with 'Type' label hereby designated as lectotype; one paralectotype female with 'Co-Typus' label.

Identity. – *Digonogastra nigripecta* comb. nov.

Ipobracon obtusicampus

Type material. – Female holotype.

Notes. – The head, propleuron and ovipositor are missing.

Identity. – *Digonogastra obtusicampa* comb. nov.

Ipobracon ochripes

Type material. – Female holotype.

Identity. – *Digonogastra ochripes* comb. nov.

Ipobracon parvispeculum

Type material. – One female with 'Type' label hereby designated as lectotype; 2 paralectotype females with 'Co-Typus' labels.

Identity. – Uncertain, appears to be closely related to *I. sexrugosus* (q.v.).

Ipobracon penniseta

Type material. – Female holotype.

Identity. – *Digonogastra penniseta* comb. nov.

Ipobracon rectivena

Type material. – Female holotype.

Identity. – *Digonogastra rectivena* comb. nov.

Ipobracon rugiventris

Type material. – One female with 'Type' label hereby designated as lectotype; one paralectotype female with 'Co-Typus' label.

Identity. – *Spathulibracon rugiventris* comb. nov.

Ipobracon sexrugosus

Type material. – Male holotype.

Identity. – Uncertain.

Ipobracon sigillatus

Type material. – Female holotype.

Identity. – *Digonogastra sigillata* comb. nov.

Ipobracon speculatus

Type material. – Female holotype.

Identity. – *Digonogastra speculata* comb. nov.

Ipobracon trirugosus

Type material. – Female holotype.

Notes. – The location of the type specimen is not indicated in Shenefelt (1978); it is in the PAN collection.

Identity. – Uncertain.

Ipobracon tuberculatus

Type material. – Female holotype.

Identity. – *Digonogastra tuberculata* comb. nov.

Megagonia breviseta

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 1 female paralectotype with 'Co-Typus' label.

Identity. – *Iphiaulax breviseta* comb. nov.

Megagonia griseiseta

Type material. – Female lectotype hereby designated; one female paralectotype.

Identity. – *Zaglyptogastra griseiseta* comb. nov.

Megagonia plumiseta

Type material. – One female with 'Type' label hereby designated as lectotype; 1 paralectotype female with 'Co-Typus' labels.

Notes. – The lectotype is in poor condition with no head or anterior metasoma. The other specimen with 'Co-Typus' label was not selected, since, although its head is present, the mesosoma is damaged.

Identity. – *Zaglyptogastra plumiseta* comb. nov.

Merinotus bispeculum

Type material. – One female with 'Type' label hereby designated as lectotype; four paralectotype males, one with 'Type' and three with 'Co-Typus' labels.

Identity. – *Shelfordia bispeculum* comb. nov.

Merinotus criniseta

Type material. – One female with 'Typus' label hereby selected as lectotype and so labelled; one male paralectotype with 'Type' label; 3 female paralectotypes with 'Co-Typus' labels.

Identity. – *Shelfordia criniseta* comb. nov.

Merinotus flagriseta

Type material. – One female with 'Type' label hereby designated as lectotype; sixteen paralectotype females with 'Co-Typus' labels.

Additional material. – Five males det. as *flagriseta* by Enderlein but without 'Co-Typus' labels.

Notes. – No opinion is being given here as to whether the males that were tentatively identified by Enderlein are conspecific with the females of the type series.

Identity. – *Shelfordia flagriseta* comb. nov.

Merinotus gibber

Type material. – One female with 'Type' label hereby designated as lectotype; 106 paralectotype females with 'Co-Typus' labels.

Notes. – All the specimens in the type series appear to be conspecific; the type series is currently split between two cabinet drawers.

Identity. – *Cratobracon gibber* comb. nov.

Merinotus gracilis

Type material. – Holotype.

Notes. – The metasoma is missing but Enderlein's label and original description indicate that it is a female.

Identity. – *Nesaulax gracilis* comb. nov.

Merinotus ingentiseta

Type material. – One female with 'Type' label hereby selected as lectotype; one female paralectotype with 'Co-Typus' label.

Identity. – *Shelfordia ingentiseta* comb. nov.

Merinotus laticampus

Type material. – One female with 'Type' label hereby selected as lectotype and so labelled; one male paralectotype with 'Type' label; fourteen female paralectotypes with 'Co-Typus' labels.

Notes. – The lectotype and the paralectotype male are not congeneric; the paralectotype male belongs to the genus *Shelfordia* Cameron.

Identity. – *Gronaulax laticampus* comb. nov.

Merinotus nigriseta

Type material. – One female with 'Type' label hereby selected as lectotype and so labelled; eight female paralectotypes with 'Co-Typus' labels.

Identity. – *Gammabracon nigriseta* comb. nov.

Merinotus quadricarinatus

Type material. – One female with 'Type' label hereby selected as lectotype; 1 'male' paralectotype with a 'Type' label; 89 female paralectotypes with 'Co-Typus' labels.

Notes. – The 'male' paralectotype is in fact a female with the ovipositor broken off near its base.

Identity. – *Shelfordia quadricarinata* comb. nov.

Merinotus rimicuneus

Type material. – One female with 'Type' label hereby selected as lectotype and so labelled; one male paralectotype with 'Type' label; 2 female and 1 male paralectotypes with 'Co-Typus' labels.

Identity. – *Shelfordia rimicunea* comb. nov.

Merinotus ruficauda

Type material. – Female holotype.

Identity. – *Rhadinobracon ruficauda* comb. nov.

Merinotus trispiculum

Type material. – One female with 'Type' label hereby designated as lectotype; four paralectotype males, one with 'Type' and three with 'Co-Typus' labels.

Identity. – Uncertain.

Monolcia angulosa

Type material. – One female with 'Type' label hereby designated as lectotype; 5 female paralectotypes with 'Co-Typus' labels.

Identity. – *Campyloneurus angulosus* comb. nov.

Monolcia apicalis

Type material. – One female with 'Type' label hereby designated as lectotype and so labelled; one male paralectotype with 'Type' label; three female paralectotypes with 'Co-Typus' labels.

Identity. – Belongs to *Pachybracon* Cameron-group.

Monolcia consimilis

Type material. – 1 female with 'Type' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Identity. – Uncertain.

Monolcia flavicosta

Type material. – One female with 'Type' label hereby designated as lectotype; 1 paralectotype female with 'Co-Typus' label.

Notes. – The lectotype has the metasoma glued on to the mesosoma.

Identity. – Provisionally included in *Campyloneurus* despite its apically truncate scapus. *Campyloneurus flavicosta* comb. nov.

Monolcia flavimarginata

Type material. – Female holotype.

Identity. – Uncertain.

Monolcia serenimanus

Type material. – One female with 'Type' label hereby designated as lectotype; 1 paralectotype female with 'Co-Typus' label.

Notes. – The lectotype and paralectotype do not appear to be conspecific, the paralectotype having a preapical dorsal nodus and apico-ventral serrations on the ovipositor, both of which are absent in the lectotype.

Identity. – Uncertain.

Monolcia tricarinata

Type material. – Female holotype.

Notes. – This is the type species of *Monolcia* Enderlein which is hereby synonymized with *Campyloneurus* Szépligeti.

Identity. – *Campyloneurus tricarinatus* comb. nov.

Odontopygia tridentata

Type material. – One female with 'Typus' label hereby designated as lectotype; 2 female paralectotypes with 'Co-Typus' labels.

Notes. – This is the type species of *Odontopygia* Enderlein which was synonymized with *Trigastrostrotheca* Cameron by Quicke (1987).

Identity. – *Trigastrostrotheca tridentata*: Quicke (1987).

Plagiozina pravivena

Type material. – One female with 'Type' label hereby designated as lectotype; one male paralectotype with 'Type' label; eight female and one male paralectotypes with 'Co-Typus' labels.

Notes. – This is the type species of *Plagiozina* Enderlein which was synonymized with *Nesaulax* Roman by Quicke (1984a) and is most likely a synonym of *N. flagellaris* Roman, 1913.

Identity. – *Nesaulax pravivena*: Quicke (1984a)

Platybracon carinicornis

Type material. – One female with 'Typus' label hereby designated as lectotype; 5 female paralectotypes with 'Co-Typus' labels.

Notes. – *Platybracon Szépligeti* is a junior synonym of *Chaoilta* Cameron (see Roman 1913, Quicke 1987); however, the two were dealt with separately in Shenefelt's (1978) catalogue.

Identity. – *Chaoilta carinicornis* comb. nov.

Platybracon celebensis

Type material. – Female holotype.

Notes. – See *P. carinicornis* (above). Belongs to the *decorata* group of species having a horn-like projection above the plate-like facial projection.

Identity. – *Blastomorpha celebensis* comb. nov.

Platybracon comptus

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 female paralectotype with 'Co-Typus' label.

Notes. – See *P. carinicornis* (above).

Identity. – *Chaoilta compta* comb. nov.

Pseudospinaria sannio

Type material. – Female holotype.

Notes. – Erroneously included in the Exothecinae by Enderlein (1920: 54); *Pseudospinaria* Enderlein is also a member of the Braconinae.

Identity. – *Trispinaria sannio* comb. nov.

Rhadinobracon rhyssides

Type material. – Female holotype.

Identity. – *Ischnobracon rhyssides* comb. nov.

Rhamnura capillicauda

Type material. – Lectotype female (designated by Shenefelt 1978: 1719); 4 female and 1 male paralectotype are in the Museum für Naturkunde in Berlin.

Notes. – Redescribed and illustrated by van Achterberg (1981).

Identity. – *Rhamnura capillicauda*.

Rhamnura filicauda

Type material. – Lectotype female (designated by Shenefelt 1978: 1719); 2 paralectotype females are in the Museum für Naturkunde in Berlin.

Identity. – *Rhamnura filicauda*.

Syntomernus pusillus

Type material. – One female with 'Type' label hereby designated as lectotype and so labelled; one 'male' paralectotype with 'Type' label; 5 female paralectotypes with 'Co-Typus' labels.

Notes. – The 'male' paralectotype has no metasoma and therefore its sex cannot be verified.

Identity. – *Syntomernus pusillus*.

Udamolcia albescens

Type material. – One female with 'Typus' label is damaged, therefore we designate hereby one of the two females with 'Co-Typus' label as lectotype; 2 female paralectotypes one with 'Type' and one with 'Co-Typus' label.

Notes. – This is the type species of *Udamolcia* Enderlein which was synonymized with *Pachybracon* Cameron by Quicke (1984c).

Identity. – Belongs to the *Pachybracon*-group.

Udamolcia albimanus

Type material. – Male holotype. In the collection under *Campyloneurus*.

Identity. – Uncertain.

Udamolcia denticornis

Type material. – One female with 'Typus' label hereby designated as lectotype; 22 female paralectotypes with 'Co-Typus' labels.

Identity. – Uncertain; a member of the *Atanycolus* Foerster group (see Quicke 1987).

Udamolcia gracilis

Type material. – Male holotype. In the collection under *Campyloneurus*.

Identity. – Uncertain. Belongs to the *Campyloneurus*-group.

Udamolcia insolita

Type material. – Female holotype. In the collection under *Campyloneurus*.

Identity. – Belongs to the *Pachybracon*-group.

Udamolcia jucunda

Type material. – Female holotype.

Identity. – *Undabracon jucundus* comb. nov.

Udamolcia laqueata

Type material. – One female with 'Typus' label hereby designated as lectotype; 1 male paralectotype with 'Typus' label; 3 female and 1 male paralectotypes with 'Co-Typus' labels.

Identity. – *Cordibracon laqueatus* comb. nov.

Udamolx aterimma

Type material. – Female holotype.

Identity. – *Digonogastra aterimma* comb. nov.

Udamolx atricauda

Type material. – Male holotype.

Identity. – *Archibracon atricauda*: Quicke (1989a).

Udamolx catharinensis

Type material. – One female with 'Type' label hereby designated as lectotype; 1 female and 1 male paralectotypes with 'Co-Typus' labels and 1 male paralectotype without 'Co-Typus' label.

Identity. – *Hemibracon catharinensis* comb. nov.

Udamolx gutta

Type material. – Female holotype.

Notes. – This is the type species of *Udamolx* Enderlein which was synonymized with *Archibracon* Saussure by Quicke (1983).

Identity. – *Archibracon cameroni* Brues (synonymized by Quicke 1989a).

Udamolx polita

Type material. – Female holotype.

Identity. – *Hemibracon politus* comb. nov.

Udamolx vaucristatum

Type material. – 1 female with 'Type' label is the holotype. The male (with only Enderlein's identification label) was excluded from the type series by Enderlein (1920: 100).

Identity. – *Hemibracon vaucristatus* comb. nov.

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We would like to thank Professor Dr B. Pisarski, Dr E. Kierych, Mr P. Marczak (PAN) and Magda Kierych for their help and hospitality during our visits to Warsaw and Lomna. Partly this research was made possible by a Royal Society short term exchange awarded to the senior author.

REFERENCES

Achterberg, C. van, 1981. The position of the genus *Rhamnura* Enderlein among the Braconidae, Hyme-

noptera). – Entomologische Berichten, Amsterdam 41: 88-91.

Achterberg, C. van, 1983. Six new genera of Braconinae from the Afrotropical Region (Hymenoptera, Braconidae). – Tijdschrift voor Entomologie 126: 175-202.

Donaldson, J. S., 1988. Revision of the braconid genus *Physaraia* (Hymenoptera, Ichneumonoidea). – Systematic Entomology 14: 15-39.

Enderlein, G., 1905a. *Rhamnura*, eine neue Braconiden-gattung mit ausserordentlich langem Legrohr des Weibchens. – Zoologischer Anzeiger 29: 195-198.

Enderlein, G., 1905b. Neue Braconiden aus dem indischen und afrikanischen Gebiet. – Stettiner Entomologische Zeitung 66: 227-236.

Enderlein, G., 1920. Zur Kenntnis aussereuropäischer Braconiden. – Archiv für Naturgeschichte 84(A) (11): 51-224.

Fahringer, 1931. Opuscula braconologica. 2. Aethiopischen Region. Lieferung 5: 305-384.

Granger, Ch., 1949. Braconides de Madagascar. – Mémoires de l'Institut Scientifique de Madagascar, A) 2: 1-428.

Quicke, D. L. J., 1981. A reclassification of some Oriental and Ethisopian species of Braconinae (Hymenoptera: Braconidae). – Oriental Insects 14: 493-498.

Quicke, D. L. J., 1983. The Afrotropical genus *Archibracon* Saussure (Hymenoptera: Braconidae: Braconinae): Characteristics and new generic synonymy. – Entomologist's monthly magazine 119: 147-150.

Quicke, D. L. J., 1984a. Two new genera of Afrotropical Braconinae (Hymenoptera: Braconidae) with a partial review of those genera with 'merinotoid' metasomas. – Entomologist's Monthly Magazine 120: 37-45.

Quicke, D. L. J., 1984b. Redescription of *Craspedolcus* with notes on included species and related genera (Hymenoptera: Braconidae). – Oriental Insects 18: 354-360.

Quicke, D. L. J., 1984c. Further reclassification of Afro-tropical and Indo-Australian Braconinae (Hymenoptera: Braconidae). – Oriental Insects 18: 339-353.

Quicke, D. L. J., 1987. The Old World genera of Braconine wasps (Hymenoptera: Braconidae). – Journal of Natural History 21: 43-157.

Quicke, D. L. J., 1989a. Parasitic braconine wasps of the genus *Archibracon* (Hymenoptera: Braconidae). – Journal of Natural History 23: 29-70.

Quicke, D. L. J., 1989b. The Indo-Australian and E. Palearctic braconine genus *Eurobracon* (Hymenoptera: Braconidae: Braconinae). – Journal of Natural History 23: 775-802.

Quicke, D. L. J., 1989c. Reclassification of some New World species of Braconinae (Hym., Braconidae). – Entomologist's monthly magazine 125: 119-121.

Roman, A., 1913. Philippinische Schlupfwespen aus dem schwedischen Reichsmuseum. I. – Arkiv för Zoologi 8: 7-59.

Shenefelt, R. D., 1978. Hymenopterorum Catalogus (nov. ed.). Part 15. Braconidae, vol. 10. – The Hague, Junk, pp 1425-1865.

Watanabe, C., 1932. A revision of Braconid species parasitic in the injurious insects of rice plant and sugar cane in Japan and Formosa. – Transactions of the Sapporo Natural History Society 12: 63-72.

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R. T. A. SCHOUTEN

Museon, Den Haag

A NEW SPECIES OF *EUCHROMIUS* GUENÉE, 1845

(LEPIDOPTERA: PYRALIDAE: CRAMBINAE)

FROM AUSTRALIA

Schouten, R. T. A., 1990. A new species of *Euchromius* Guenée, 1845 (Lepidoptera: Pyralidae: Crambinae) from Australia. – Tijdschrift voor Entomologie 133: 265-267, figs. 1-5. [ISSN 0040-7496]. Published 14 December 1990.

Euchromius cornus sp. n. is described from Australia. The external characters, male and female genitalia are described and figured in detail.

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Key words. – Pyralidae; Crambinae; *Euchromius*; Australia; new species.

Presumably in 1991, a checklist of the Lepidoptera of Australia will be published. The only species of *Euchromius* occurring in Australia is described in this article to have the name available for this checklist. A revision of the other species will be published shortly.

RTAS refers to author's collection, other abbreviations (codens) used in the list of type material follow Arnett & Samuelson (1986). The terminology used in the descriptions follows Schouten (1988).

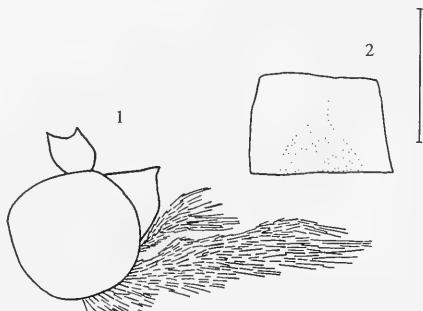
Euchromius cornus sp. n. (figs. 1-5)

Type material. – Holotype: ♂, 'Sherlock R. W. Australia. E. Clements: 98-188,' genitalia slide 17616 BM (BMNH). – Paratypes: 1 ♂, Alexandria (BMNH); 1 ♂, Comrav (BMNH); 2 ♂, 4 ♀, Broken Hill (RTAS, SAMA); 1 ♂, to Alhanna above Column (SAMA); 1 ♂, Stevenson River (SAMA); 2 ♂, 1 ♀, 3 km. NW by W. of Millstream HS. (ANIC); 1 ♂, 2 ♀, 1 km. NE of Millstream HS. (ANIC, RTAS); 1 ♂, 1 ♀, 1 km. N. of Millstream HS. (ANIC, RTAS); 1 ♀, 1/2 km. WNW of Millstream HS. (ANIC); 2 ♂, 1km NNE of Millstream WA (ANIC, RTAS); 1 ♂, Camooweal (ANIC); 1 ♀, 31 km NNW Longreach, Q. (ANIC); 1 ♂, Kimberley Research Stn Via Wyndham N. W. Aust. (ANIC); 2 ♂, Ivanhoe. W. A (ANIC, RTAS); 1 ♂, Moora W Q (ANIC); 1 ♀, Limestone Creek, 42 km NNW of Boulia, Q. (ANIC); 1 ♀, JimJim Creek 19 km WSW of Mt. Cahill, N. T. (ANIC); 1 ♂, Charleville Q. (ANIC); 2 ♂, 1 ♀, Injune Q. (ANIC, RTAS); 1 ♀, Cunnamulla Q. (ANIC); 1 ♂, 1 ♀, Adaville Q. (ANIC); 1 ♀, Millmerran Q. (ANIC).

Diagnosis. – Externally almost indistinguishable from *Euchromius* species with a double medial fas-

cia and frons with one point. Differs in male genitalia from all species in having the uncus armed with a short, double, dorsal projection. Differs in female genitalia from *E. geminus*, *E. californicalis*, *E. limaellus*, *E. ocellatus*, *E. saltalis*, *E. mythus* and *E. tanalis* in having a short ductus bursae without clear sclerotizations.

External characters (fig. 1). – Wingspan 16-22 mm. Frons produced forward, conical with clear point, creamy white, no ventral ridge; vertex creamy white; labial palp two to two and a half, sides creamy white at base, becoming light brown, creamy white from above and below; maxillary palp creamy white to light brown, dark ringed at base of last segment; antenna creamy white. Thorax creamy white to light brown; patagia creamy white; tegulae creamy white, evenly mottled. Forewing,



Figs. 1-2. *Euchromius cornus*. 1, Head, lateral aspect, scales removed, scale 1 mm; 2, Male, sclerotization of tergite VIII, scale 1 mm.

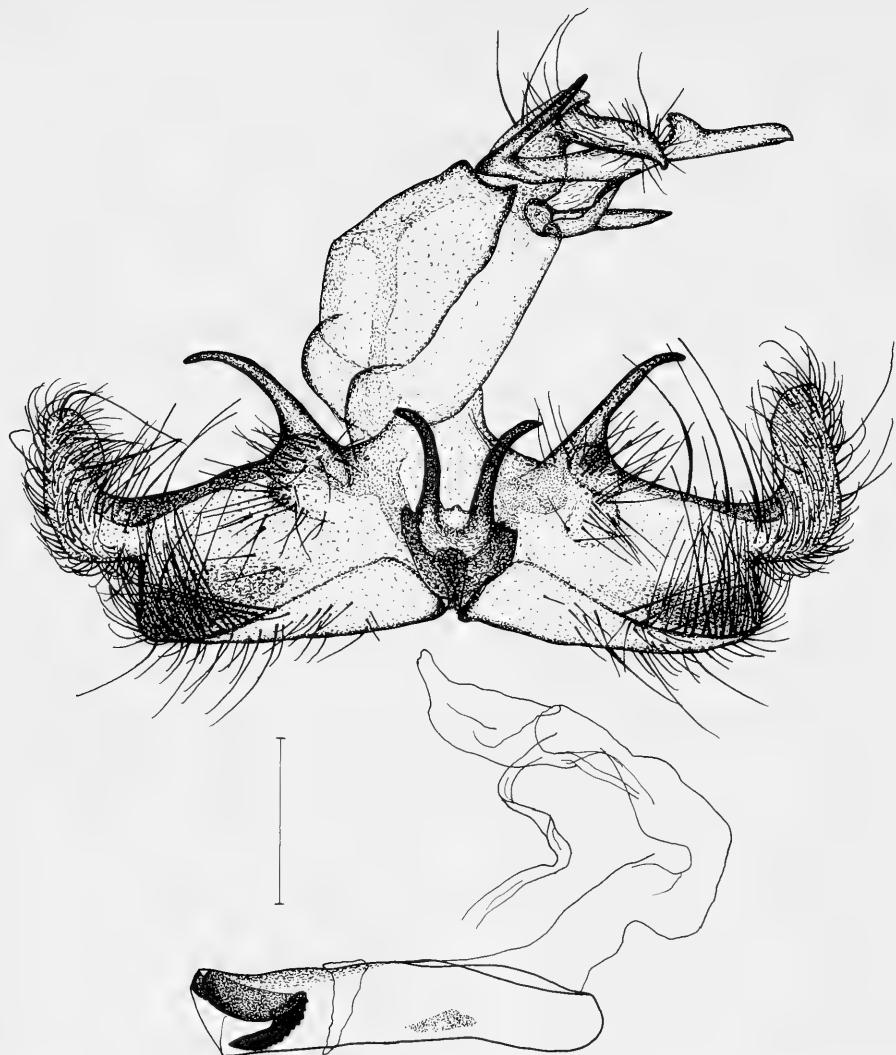


Fig. 3. *Euchromius cornus*, male genitalia, holotype; ventro-caudal aspect, valvae spread; aedeagus separated, lateral aspect, slide BM 17616, scale 0.5 mm.

groundcolour creamy white densely suffused with ochreous brown to brown scales; medial fascia double, arched to nearly straight, running to one-sixth to one-fifth of the dorsum; subterminal line ochreous brown, inconspicuous, slightly closer to termination of posterior area than to terminal dots, sometimes about halfway between terminal dots and termination of posterior area; area adjacent to terminal dots white; eight or nine black terminal dots, formula 2-2-3-1 or 1-2-3-2 or 2-2-3-2; fringes shiny, creamy white with two to three brown lines. Hindwing creamy white, subterminal fascia absent, termen darkly bordered; fringes white with creamy white line.

Tergite VIII (fig. 2). - Tergite normally sclerotized, posterior part triangular, stalk only partly visible, anterior pattern not visible.

Male genitalia (fig. 3). - Uncus with a short, double, dorsal projection; gnathos longer, with dorsal dagger-shaped projections at each side of base, two dorsal thorns relatively large, terminal part long; tegumen without appendix angularis; sacculus normal, processus of sacculus absent, processus basalis long strongly sclerotized, two processi inferiores valvae, cucullus club-shaped, bent upward; juxta triangular, armed with two dorsal projections; vinculum small; aedeagus normal sized, one dentate cornutus anterior of anellus connection, second,

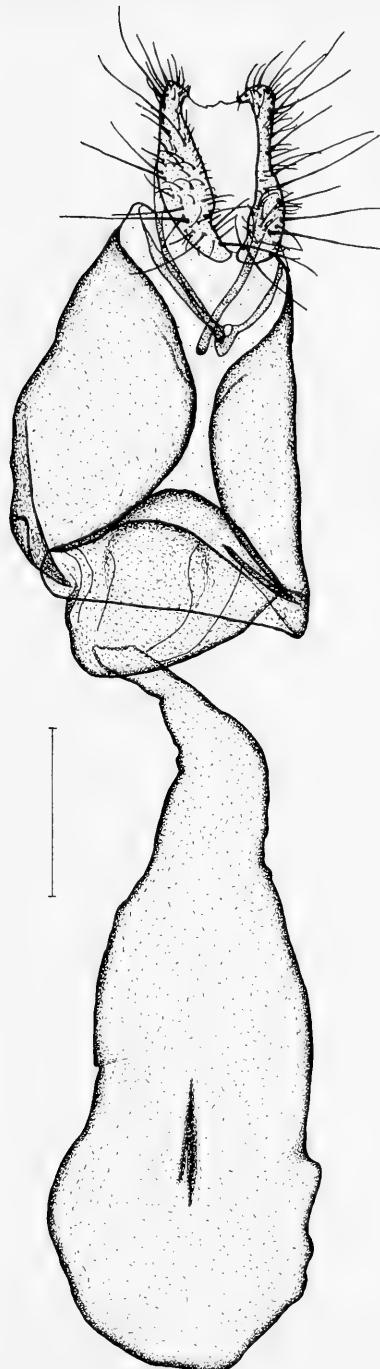


Fig. 4. *Euchromius cornutus*, female genitalia; ventral aspect, slide BM 17469, scale 0.5 mm.



Fig. 5. Distribution of *Euchromius cornutus*.

fainter group of cornuti more posterior.

Female genitalia (fig. 4). — Papillae anales normal; membrane of tergite VIII with cord-like sclerotization, edges of tergite VIII not connected; ostium lip-shaped; ductus bursae short, broad under ostium; ductus seminalis narrow; bursa copulatrix oblong, two long signa, about equal in size.

Ecology. — Unknown. Two generations, the first starts in February and ends at the end of May, most specimens were caught in April and May. The second generation flies from August to the end of November, most specimens in September and October.

Distribution (fig. 5). — Restricted to Australia, where it can be found in most provinces.

REFERENCES

- Arnett, R. H. & G. A. Samuelson, 1986. The insect and spider collections of the world. 220 pp. — E.J. Brill/Flora & Fauna publications, Gainesville.
- Haworth, A. H., 1811. Lepidoptera Britannica, 3: 377-511. — London.
- Schouten, R. T. A., 1988. Revision of the species of the genus *Euchromius* Guenée, 1845 (Lepidoptera: Pyralidae: Crambinae) occurring in the Afrotropical region. — Zoologische Verhandelingen Leiden 244: 1-64.

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BOOK ANNOUNCEMENTS AND REVIEWS

Larsen, T.B., 1990. The butterflies of Egypt. – Apollo Books, Lundbyvej 36, DK-5700 Svendborg, Denmark: 1-112, figs. 1-7, tables 1-4, plates 1-8. [ISBN 87 8875 14 5, price 240 Danish Crowns].

The current knowledge of the butterflies of Egypt is summarized for the first time since 1948. All 58 species are depicted in full colour, together with some photo's of the most characteristic habitats. For each species the distribution inside and outside Egypt is discussed together with their taxonomical status, ecology and habitat preferences.

Separate chapters deal with the ecological zones of Egypt and its characteristic species, the biogeography, migrant species, economic importance and species expected to be found in Egypt in the near future. This book is recommended warmly to everyone working on Mediterranean butterflies or intending to visit Egypt.

[R. T. A. Schouten]

Merzheevskaya, O. I., 1989. Larvae of owl moths (Noctuidae). Biology, morphology, and classification. – Amerind Publishing Co, New Delhi (outside India exclusively marketed by E. J. Brill, Leiden etc): i-xx + 1-419, figs. 1-97. ISBN 90-04-08804-0. Price 115.- Dutch guilders (appr. US \$57.50).

This book is a translation of 'Gusenitsy Sovok (Noctuidae), ikh Biologiya i Morfologiya (Opredelitel')', which was published in 1967. It provides information on the biology and morphology of owl moth larvae and keys to their subfamilies, genera, and species. Morphological characters, body coloration, and dermal patterns are detailed for each species. The larvae of 144 species of owl moths are described and data on developmental changes in instars given for 91 of them.

This book should be helpful to entomologists, agricultural entomologists, plant-protection specialists, and teachers and students of biology, agriculture, and forestry.

[Information from the publisher]

Oman, P. W., W. J. Knight & M. W. Nielson, 1990. Leaf-hoppers (Cicadellidae): A bibliography, generic checklist and index to the world literature 1956-1985. – CAB International Institute of Entomology, Wallingford: 1-368. ISBN 0 85198 690 0. Price not given.

The book consists of a bibliography of more than 7000 titles for the period 1956-1985, an index to the bibliography to guide users to specified subject-matter fields and a complete check-list of generic and family-group names used in the Cicadellidae. Other important features are a review of cicadellid literature for the period 1942-1955, a compilation showing usage of family-group names in the taxonomic literature during the years 1956-1985 and an alphabetized list and grouping of subfamily and tribal names within the family. The present bibliography supplements Metcalf's Bibliography of the Cicadelloidea.

[From the introduction of this book].

Williams, D. J. & G. W. Watson, 1990. The scale insects of the Tropical South Pacific region. Part 3. The Soft Scales (Coccidae) and other families. – CAB International Institute of Entomology, Wallingford, UK: 1-267, figs. 1-71. ISBN 0 85198 659 5. Price not given.

A continuation of the series started by the same authors in 1988 (cf. Tijdschrift voor Entomologie 132: 114). The families discussed in the present volume are Margarodidae, Ortheziidae, Eriococcidae, Dactylopiidae, Coccidae, Cerococcidae, Lecanodiaspididae, Kerriidae, Asterolecaniidae, Conchaspididae and Halimococcidae. Keys are provided to the families and genera, and many new species are described and illustrated.

[From the abstract].

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A NEW SPECIES OF *AUSTRODECUS* (PYCNOGONIDA) FROM NEW SOUTH WALES, AUSTRALIA

Stock, Jan H., 1990. A new species of *Austrodecus* (Pycnogonida) from New South Wales, Australia. – Tijdschrift voor Entomologie 133: 269-272, figs. 1-9. [ISSN 0040-7496]. Published 14 December 1990.

Austrodecus staplesi sp.n. is the first member of the genus described from continental Australia (New South Wales). The genus is mainly Gondwanian in its distribution, but for three species recorded from the western belt of the Pacific Ocean.

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Key words. – *Austrodecus*; Pycnogonida; New Species; New South Wales; biogeography.

The genus *Austrodecus* s.str. counts actually 24 named and 5 unnamed species (Stock 1957, 1968, Hedgpeth & McCain 1971, Clark 1972a, b, Child 1983, 1988, Pushkin 1977). The genus was briefly mentioned, without specific identification, in a popular paper by Staples (1977: 123) from 'southern Australian waters ... [where it] may be associated with the hydroid *Halicorniopsis elegans*'. With the exception of one dubious record of *A. glaciale* Hodgson, 1907, off Tasmania (see Gordon 1944: 6, Stock 1957: 46), there are no other Australian records, and as far as I know Staples' Australian material never has been formally described.

Through the courtesy of Dr. Harry A. ten Hove, Amsterdam, I received a single specimen, fortunately a male, of an *Austrodecus* collected on the coasts of New South Wales. It represents a new species, described in this paper.

Family AUSTRODECIDAE Stock, 1954
Genus *Austrodecus* Hodgson, 1907

Austrodecus staplesi sp.n.

(figs. 1-8)

Type material. – 1 ♂ (holotype), Australia, New South Wales, Split Solitary Island, near Coff's Harbour; depth 12-14 m; rocky area with small caves, some corals, algae and some sand; 26 Apr. 1986; leg. H. A. ten Hove, P. Hutchings & R. Phipps (Zoölogisch Museum Amsterdam Pa. 3322).

Description

Holotype ♂. – The new species belongs to the *gordonae*-section (Stock 1957) of the genus, char-

acterized by a 4-segmented oviger and the absence of auxiliary claws.

Trunk (figs. 1-2) with 4 tall mid-dorsal spurs, one on each trunk segment. Ocular tubercle taller than trunk spurs, but rather plump; eyes well-pigmented. Less tall dorsal spurs on coxa 1 of legs 1 and 4 (1 spur), coxa 1 of legs 2 and 3 (2 spurs), and coxa 3 of legs 1 to 4 (1 spur). Abdomen (fig. 1) tuberculate, slightly overreaching coxa 3 of leg 4.

Palp (fig. 3) 5-segmented, segment 5 indistinctly subdivided, bifid (fig. 4). Oviger 4-segmented, 1 spine on segment 3, 2 median and 4 distal spines on segment 4 (fig. 5).

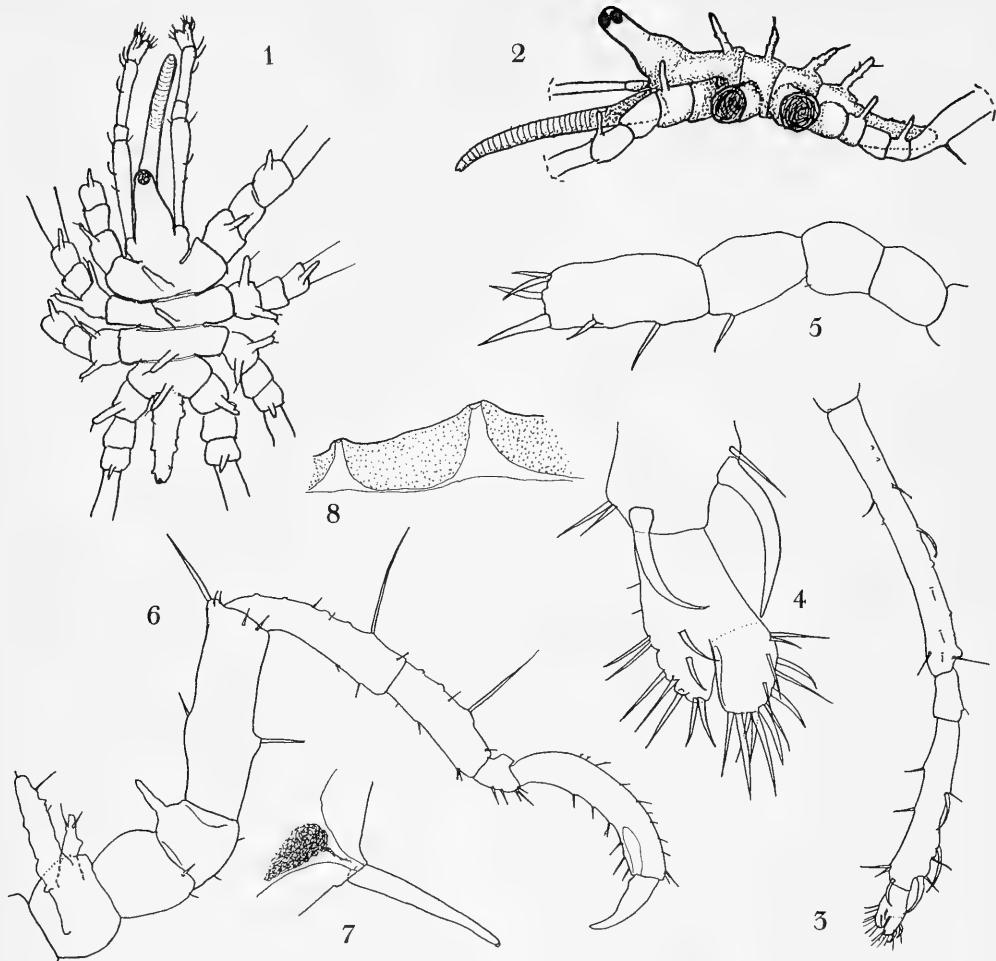
Legs (fig. 6) with a long dorsodistal seta on femur and tibiae 1 and 2. Femur longest segment. Femoral cement gland ventral, situated slightly before middle of segment; discharging through long duct (fig. 7). Other glands open through slightly raised pores (fig. 8) on dorsal surface of tibia 1 (4 pores) and tibia 2 (2 pores). Propodus strongly curved; sole with c. 6 spinules; no auxiliary claws. As far as I can ascertain, male genital pores situated on ventral surface of coxa 3 (!) of all (!) legs.

Measurements of holotype (in μm). – Length trunk (tip ocular tubercle to tip abdomen) 1556; length cephalic segment 653; width across 2nd lateral processes 539; length abdomen 406; length proboscis 1099.

Third leg: first coxa 144; second coxa 144; third coxa 101; femur 376; first tibia 264; second tibia 241; tarsus 49; propodus 269; claw 120.

Remarks

Within the *gordonae*-section, the new species



Figs. 1-8. *Austrodecus staplesi* n.sp., ♂ holotype. 1, body, dorsal; 2, body, from the left; 3, palp; 4, distal part of palp; 5, oviger; 6, third leg; 7, femoral cement gland; 8, gland apertures on dorsal surface of tibia 2 of leg 3.

differs from *A. frigorifugum* Stock, 1954, *A. stocki* Child, 1988, and *A. oblongum* Pushkin, 1977 (generic status of the latter uncertain because of aberrant shape of proboscis) in the absence of dorso-distal femoral spurs. *A. gordonaee* Stock, 1954, has low mid-dorsal trunk tubercles, an almost straight and shorter propodus, and lacks a femoral cement gland tube. *A. palauense* Child, 1983 has a longer distal tubercle on palp segment 2, as well as tuberculate and widely separated lateral trunk processes; the oviger of this species is unknown.

As point of fact, only three species of *Austrodecus* share with the new species the presence of a tubiform cement gland aperture located in the middle part of the ventral surface of femur. Two of these, *A. aconae* (Hedgpeth & McCain, 1971), originally described as a species of *Pantopipetta*,

and *A. kelpi* Pushkin, 1977 differ from the new species in the absence or poor development of mid-dorsal trunk spurs, and in the axial implantation of the distal palp segment. The other species, *A. tubiferum* Stock, 1957, shows no doubt the greatest resemblance to the new species. *A. tubiferum* is known from Sagami Bay (Stock 1954, 1957) and Okinawa (Child 1988), and has a similar pattern of spurs on trunk and legs. The new species differs from *A. tubiferum* in having longer mid-dorsal trunk spurs, a more strongly curved propodus, a slightly different configuration of the distal palp segments, and less slender legs (especially on the level of tibia 2). The propodus of *A. staplesi* longer than tibia 2, that of *A. tubiferum* longer than tibia 2.

The new species differs from all other members

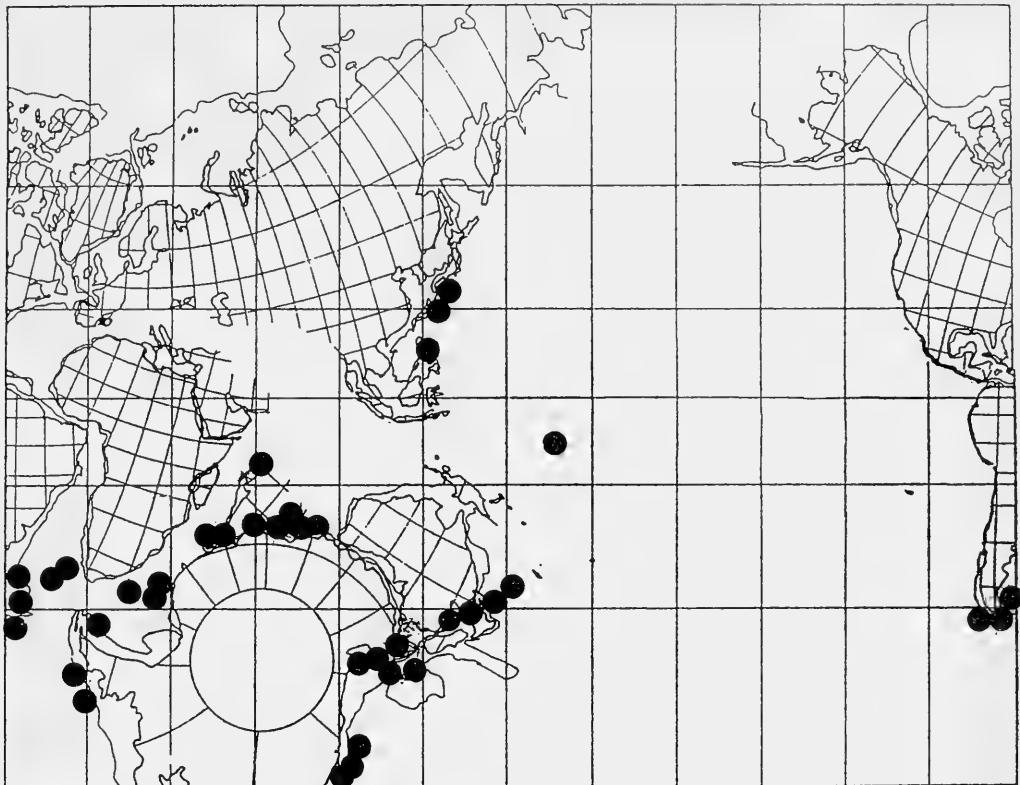


Fig. 9. Global reconstruction at 100 Ma B.P., after Smith & Briden, 1977. Dots indicate the actual distribution of the 24 named and 5 unnamed species of the genus *Austrodecus* (some species known from more than one locality, some localities with more than one species). With the exception of the Japanese, Palau and Kermadec records, the distribution is essentially Gondwanian.

of the genus in the combination of 4-segmented ovigers and lacking auxiliary claws.

Etymology

This species is dedicated to Mr. David Staples, of Melbourne, in recognition of his works on Australian Pycnogonida.

Biogeography

Child (1983: 699, 1988: 55) has suggested a 'western Indian Ocean corridor' and a 'western Pacific corridor' to explain the presence of *Austrodecus* species on Aldabra Atoll (Indian Ocean), and in warm or warm-temperate waters in the western Pacific (Kermadec Islands, Palau, Japan). Stock (1957: 24, fig. 10) presumed a relationship to the plate tectonics of the southern hemisphere land masses, long before plate drift was a fashionable subject. Fig. 9 shows that (when the distribution of *Austrodecus* is plotted on a late Mesozoic map of the continents), the genus is essentially Gondwanian, with extensions along the western margin of the Pacific Ocean.

REFERENCES

- Child, C. A., 1983. Pycnogonida of the western Pacific islands, II Guam and the Palau islands. – Proceedings of the biological Society of Washington 96: 698-714.
- Child, C. A., 1988. Pycnogonida from Aldabra atoll. – Bulletin of the biological Society of Washington 8: 45-78.
- Clark, W. C., 1972a. Pycnogonida of the Snares Islands. – New Zealand Journal of marine and freshwater Research 5: 329-341.
- Clark, W. C., 1972b. Pycnogonida of the Antipodes Islands. – New Zealand Journal of marine and freshwater Research 5: 427-452.
- Gordon, I., 1944. Pycnogonida. – Report of the B.A.N.Z. Antarctic Research Expedition (B) 5 (1): 1-72.
- Hedgpeth, J. W. & J. C. McCain, 1971. A review of the pycnogonid genus *Pantopipetta* (family Austrodecidae, emended) with the description of a new species. – Antarctic Research Series 17: 217-229.
- Pushkin, A. F., 1977. New species of Austrodecidae from the Antarctic. – Exploration of the Fauna of the Seas, Academy of Sciences of the U.S.S.R. 21 (29): 54-59.
- Smith, A. G., & J. C. Briden, 1977. Mesozoic and Cenozoic paleocontinental maps: 1-63 (Cambridge University Press).
- Staples, D., 1977. Pycnogonida, the "nobodies". – Australia's Oceans (Journal of the Oceans Society of Australia) 1: 122-125.

Stock, J. H., 1954. Pycnogonida from Indo-West Pacific, Australian and New Zealand waters. – Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København 116: 1-168.

Stock, J. H., 1957. The pycnogonid family Austrodecidae. – Beaufortia 6: 1-81.

Stock, J. H., 1968. Pycnogonida collected by the Galathea and Anton Bruun in the Indian and Pacific Oceans. – Videnskabelige Meddelelser fra Dansk naturhistorisk Forening i København 131: 7-65.

ZOOLOGICAL EXPEDITIONS TO THE KRAKATAU ISLANDS, 1984 AND 1985: ODONATA

Descriptions and records of Malesian Odonata, 2

Tol, J. van, 1990. Zoological expeditions to the Krakatau Islands, 1984 and 1985: Odonata. Descriptions and records of Malesian Odonata, 2. – Tijdschrift voor Entomologie 133: 273-279, figs. 1-11, tab. 1 [ISSN 0040-7496]. Published 14 December 1990.

A list of the Odonata collected by the members of the Krakatau Expeditions (1984 and 1985), organized by the La Trobe University (Melbourne) and LIPI (Jakarta). Most of the species mentioned are not from the Krakatau Islands, but from westernmost Java (Jawa) or southernmost Sumatra (Sumatera). *Agriocnemis pygmaea* (Rambur) and *Orthetrum t. testaceum* (Burmeister) are recorded from the Krakatau Islands for the first time.

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Key words. – Odonata; Malesia; Krakatau; Java; Sumatra.

Members of most entomological expeditions to the Krakataus have made collections of dragonflies (Odonata). Yukawa & Yamane (1985) recently summarized the present knowledge. Their list of references should be completed with the work of Ris (1912), since that publication provides the identifications of the specimens collected by Jacobson in May 1908, and only referred to as 'spec. 1' and 'spec. 2' by Jacobson (1909). Thornton & New (1988b) gave some preliminary results of the present material and some sight observations.

The present collection of Odonata includes considerably more species, mainly due to sampling activities in the southernmost part of Sumatra and the westernmost part of Java. A detailed account of the general results of these expeditions were given by Thornton and Rosengren (1988), while Thornton & New (1988a) deal with the freshwater communities. Presently, the only known relatively permanent water bodies on the Krakatau Islands are concrete-lined ponds, one on Sertung and two on northern Panjang. Before 1940 there were several pools and a brackish-water lake with breeding populations of eurytopic Odonata, e.g. *Pseudagrion microcephalum* (Rambur), *Ischnura senegalensis* (Rambur), *Diplacodes trivialis* (Rambur) and *Pantala flavescens* (Fabricius) (Dammerman 1948).

The following systematic account lists all species collected during the expeditions of 1984 and 1985. Species collected on the Krakatau islands Rakata, Sertung, Anak Krakatau or Panjang are marked with an asterisk. All records are given in full, but

data on longitude-latitude are summarized in the next paragraph.

LOCALITIES

Sumatra. – Liwa (1), sweeping, 5°04'S 104°03'E; Liwa (2), secondary forest, sweeping, 700 m, 5°04'S 104°03'E; Liwa (4), 5°04'S 104°03'E.

Krakatau Islands. – Rakata, Owl Bay, 6°09'S 105°28'E; Panjang, 6°05'S 105°28'E; Anak Krakatau, sweeping, 6°06'S 105°26'E; Sertung, forest, 6°05'S 105°23'E; Sertung, Spit, 6°04'S 105°24'-25'E.

Java. – Ujung Kulon, Pulau Peucang, 6°45'S 105°15'E; Ujung Kulon, Cideon, 6°46'S 105°15'E; Ujung Kulon, Cibunar, 6°48'S 105°17'E; Hills behind Carita.

The present and former names of the islands are: Rakata, also known as Rakata Besar and Krakatau; Panjang, also known as Rakata Kecil and Lang eiland; Sertung, also known as Verlaten eiland. Compilation of information on topography and the history of events are to be found in Dammerman (1948), and the more recently published works of Simkin & Fiske (1983) and Thornton & Rosengren (1988).

SYSTEMATIC LIST

The systematic list follows Davies & Tobin (1984, 1985). Records for each species are arranged in chronological order. Short comments on distribution and abundance of the species are given, us-

ually based on Lieftinck's publications (Lieftinck 1934, 1935, 1953 and 1954) and the RMNH collection, Leiden. Special attention was paid to notes giving details about occurrence in southern Sumatra and western Java. Especially Lieftinck's records of 'Mt Tanggamoes' [= Gunung Tanggamus] are of great interest for the interpretation of the observations from Liwa. The status of Odonata before 1940 is well established through many collecting trips of entomologists working for the Bogor museum (formerly Buitenzorg).

Abbreviations used: RMNH = National Museum of Natural History, Leiden.

Family Amphiptyerygidae

Devadatta argyoides (Selys, 1859)

Sumatra, Liwa (2), 191 BB, 1 Sep 1984, 1 female.

Although generally uncommon, it was very abundant in the Gn Tanggamus area in December 1934 (Lieftinck 1935).

Family Calopterygidae

Neurobasis chinensis chinensis (Linnaeus, 1758) (fig. 1)

Sumatra, Liwa (2), 191 BD, 1 Sep 1984, 1 male; Idem, 191-BA, 1 female.

The nominal subspecies is common on Sumatra, including the southernmost part. Javanese populations are ranked as a separate subspecies, *N. chinensis florida* Hagen.

Vestalis luctuosa (Burmeister, 1839)

Sumatra, Liwa (2), 191 BC, 1 male.

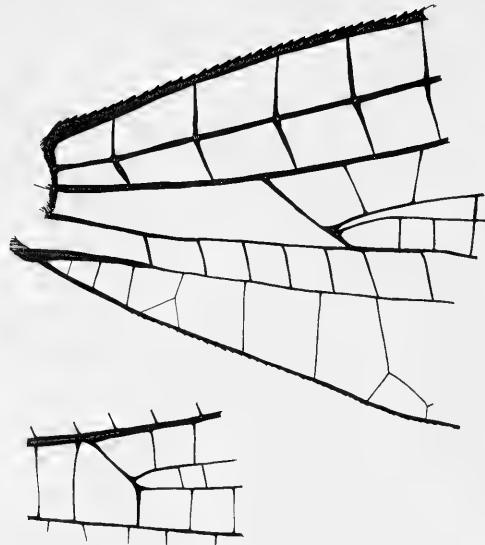
Java, Ujung Kulon, Cidaon, 190 GA and 190 HC, 15 Sep 1984, 1 male, 1 female; Idem, 190 ND, 16 Sep 1984, 1 male.

Vestalis luctuosa is a common species on Java, but on Sumatra it is confined to the southernmost part. *V. amoena* Selys, a common species of this genus on Sumatra, was not represented.

Females of *Neurobasis chinensis* and the regional *Vestalis* species are superficially very similar, and are not easy to separate in the field, especially so, since in many specimens of *N. chinensis* the pseudopterostigma is absent. Both genera are most easily distinguishable based on their wing venation. The Arculus is oblique, but not angulated in *Vestalis*, while it is conspicuously angulated in *Neurobasis* (figs. 1 and 2) (Fraser 1933). Besides, *Neurobasis* has cross-veins in the median (basal) space. Both *Vestalis* species can be identified on the coloration of the labium (cf. Schmidt 1934: figs. 19a-b).

Vestalis lugens Selys

Sumatra, Liwa (2), 190 BE, 1 Sep 1984, 2 females; Idem, Liwa (1), 191 AA, 6 Sep 1984, 1 female; Idem,



Figs. 1-2. Wing base in Calopterygidae. - 1 (above), *Vestalis amoena*; 2, (below) *Neurobasis chinensis*.

Liwa (2), 191 AB, 7 Sep 1984, 1 female.

See remarks under *V. luctuosa*.

Family Chlorocyphidae

Rhinocypha angusta (Selys, 1853)

Sumatra, Liwa (2), 191 BD, 1 Sep 1984, 1 male.

Common on Sumatra, but absent from Java.

Rhinocypha selysi Krüger, 1898

Sumatra, Liwa (2), 191 BC, 1 Sep 1984, 1 male.

Species confined to Sumatra (contra Lieftinck 1934, cf. Lieftinck 1954). Generally a rare species, except in southern Sumatra. In the RMNH collection 18 males and 13 females are represented. Most specimens are from the Gn Tanggamus area and Benkulen; the other sites are (from north to south): Deli, Bolimbingan, 600 m (leg. Straatman) [locality not found]; Emmahaven, Padang [$1^{\circ}00' S$ $100^{\circ}22' E$] (leg. Van der Starre); Sandaran Agung (Kurintji) [= probably Sanggaran agung, Kerintji; $2^{\circ}08' S$ $101^{\circ}31' E$] (leg. Jacobson).

Family Euphaeidae

Euphaea variegata (Rambur, 1842)

Sumatra, Liwa (2), 191 BA, 1 Sep 1984, 1 male.

Java, Ujung Kulon, Cidaon, 190 HC, 15 Sep 1984, 1 female.

Widespread and common on Sumatra and Java; recorded as 'very common' from the S. Lampoeng Residency by Lieftinck (1935). It was also found on Panaitan Island (Lieftinck 1953).

Family Coenagrionidae

Agriocnemis femina (Brauer, 1868) (figs. 9-11)

Sumatra, Liwa (1), 191 AA, 6 Sep 1984, 1 female.
Eurytopic species, very common and widespread from Bengal, Assam (Fraser 1933) eastwards to northern Australia. See further notes under *A. pygmaea*.

* *Agriocnemis pygmaea* (Rambur, 1842)

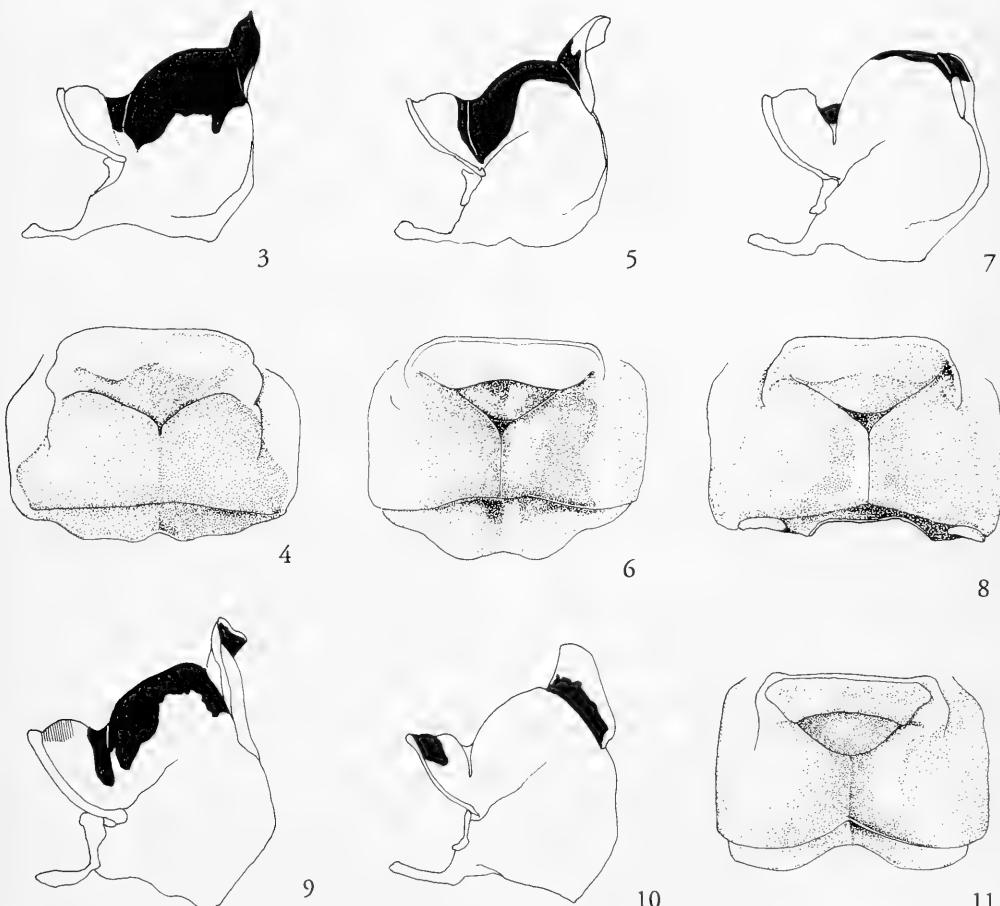
(figs. 5-8)

Krakatau Is. - Anak Krakatau, 215.DE, 21 Aug 1985, 1 female [short-lobed form, headless].

New to the Krakataus. Habitat: all kinds of stagnant waters. Presumably a wind-borne species (Lieftinck 1954). Very widespread, and usually very common in the afrotropical, oriental and australian region.

The females of *Agriocnemis* are not easy to distinguish, since both *A. femina* and *A. pygmaea* are polytypic. In this area also another species, *A. minima* Selys (figs. 3-4), has to be taken into account. I have now provisionally examined material available in the RMNH collection (figs. 3-11). It seems that at least two forms of both species based on the shape of the prothorax, can be recognized. Females of *A. pygmaea* may have a strongly developed hindlobe with a median depression, or the hindlobe is nearly completely lacking (figs. 5-8). Apart from these structural forms, there also exist two colour forms, an orange-red and a greenish-brown form. Therefore, as already stressed by Ris (1916), four forms can be recognized, since differently shaped hindlobes of the pronotum occur in both colour forms.

According to Ris (1916), *Agriocnemis femina*



Figs. 3-11. Prothorax in females of *Agriocnemis*, left lateral and dorsal view. - 3-4, *A. minima*, Java; 5-6, *A. pygmaea* long-lobed form from Sulawesi; 7-8, *A. pygmaea*, short-lobed form from Ceylon; 9, *A. femina*, form with medially depressed hind lobe, northern Borneo; 10-11, *A. femina*, form with upright hind lobe, Sumatra.

falls apart in at least four structurally different forms. Also the males of this species show geographical variation. Females of *A. femina* always have a well-developed hindlobe, but it is strongly upright in specimens from Ceylon, or it is conspicuously depressed in the middle in more eastern populations (figs. 9-11). According to Lieftinck (1954: 72 footnote) two well definable subspecies occur on Sumatra.

Family Platycnemididae

Coelicia membranipes membranipes (Rambur, 1842)

Sumatra, Liwa (1), 191 AA, 6 Sep 1984, 1 female.
Common species on Java and Sumatra in slowly flowing waters.

Family Aeshnidae

Gynacantha basiguttata Selys, 1882

Java, Ujung Kulon, 190 AG, 17 Sep 1984, 1 male.
Considered as 'rare' on Java by Lieftinck (1934); more common on Sumatra, and also known from Billiton, Simalur, Enggano and western Borneo (collection RMNH). Apparently not rare on Panaitan Island (Lieftinck 1953). Breeds in forest pools. The adults fly only at dusk, as all *Gynacantha* species.

Family Libellulidae

Agrioptera insignis insignis (Rambur, 1842)

Java, Ujung Kulon, Pulau Peucang, 15 July 1984, 190 AD, 1 male; Idem, 190 AF, AK, AP, AR, Sep 1984, 1 male 3 females; Idem, 190 AC, 20 Sep 1984, 1 female; Java, Ujung Kulon, Cibunar, 190 GB, Sep 1984, 1 male; Java, Ujung Kulon, P. Peucang, 24.1, 22 Sep 1984, 1 female.

Confined to the coastal area of a significant part of the oriental region. Locally abundant in e.g. mangrove forests. It breeds in shady pools in forests (Lieftinck 1954). Although it was once 'one of the commonest, and certainly the most striking' (Lieftinck 1934) dragonfly of the Krakataus, it was not collected there during this expedition, nor by Yukawa & Yamane (1985). The collection made in 1908 by Jacobson (Ris 1912) consisted of this species and *Diplacodes trivialis* (Rambur, 1842) only.

Cratilla lineata assidua (Lieftinck, 1953)

Java, Ujung Kulon, Pulau Peucang, 11 Sep 1984, 1 male.

A woodland species, obviously uncommon on Java. The nominotypical subspecies occurs widely on Sumatra and was once collected on the Krakatau islands, while subspecies *assidua* Lieftinck was recorded from Panaitan Island (Lieftinck 1953).

Lathrecista asiatica (Fabricius, 1798)

Java, Ujung Kulon, Pulau Peucang, 190 AJ, 13 Sep 1984, 1 male.

Although widespread in the oriental region, Lieftinck (1954) considered it uncommon on Java.

Lyriothemis magnificata (Selys, 1878)

Java, Ujung Kulon, Pulau Peucang, 190 AQ, 3 Sep 1984, 1 female.

A rare species from Sumatra, Billiton and Java. Unknown from western Java according to Lieftinck (1934), but in the RMNH collection several specimens from this area are available, e.g. Udjung Kulon, Tjibunar [river], 28 Nov 1958, 1 female.

Orthetrum sabina (Drury, 1770)

Sumatra, Liwa (1), white light, 190 AC, 31 Aug 1984, 1 female; Idem, Liwa (2), 191 BE, 1 Sep 1984, 1 male.

Java, Ujung Kulon, Pulau Peucang, 190 AN, 17 Sep 1984, 1 male; Idem, Carita, 310 A, 11 Aug 1985, 1 female. Widespread and common species; abundant in cultivated areas. Collected on the Krakataus by Yukawa & Yamane (1985).

* *Orthetrum testaceum testaceum* (Burmeister, 1839)

Sumatra, Liwa (2), 191 BA and 191 BC, 1 Sep 1984, 2 males; Sumatra, Liwa (4), 191 DA, 7 Sep 1984, 1 male.

Krakatau Is., Penjang, 3 Sep 1984, 192 BA, 1 male.

New to the Krakatau Islands. Common in the lowlands of Java and Sumatra, and also known from Panaitan Island (Lieftinck 1953). Breeding in all kind of waters (Lieftinck 1934).

* *Diplacodes trivialis* (Rambur, 1842)

Sumatra, Liwa (1), 191 AA, 6 Sep 1984, 1 female.
Krakatau Is., Anak Krakatau, 192 AA, 13 Sep 1984, 1 female; Krakatau Is., Anak Krakatau, 310B; 15 Aug 1985, 1 female; Idem, 310 C, 17 Aug 1985, 1 male; Krakatau Is., Rakata, Owl Bay, 310 F, G and H, 26 Aug 1985, 1 male 2 females.

Very common and widespread species. Recorded from the Krakataus since 1908.

Neurothemis fluctuans (Fabricius, 1793)

Sumatra, Liwa (4), 191 DB, 7 Sep 1984, 3 males 1 female; Idem, 191 DC, same date, 2 males.

See remarks under the following species.

Neurothemis fluctuans (Fabricius, 1793) / *N. ramburii* (Brauer, 1866)

Java, Ujung Kulon, Pulau Peucang, 190 AQ, Sep 1984, 1 male; Idem, 190 AH, Sep 1984, 1 female (homeochrome); Idem, (no number), 11 Sep 1984, 1 female (homeochrome); Idem, 190 AI, 11 Sep 1984, 1 female (homeochrome); Idem, 190 AL, 13

Sep 1984, 1 male; Idem, 190 AE, 15 Sep 1984, 1 female (heterochrome); Idem, 24.1, 22 Sep 1984, 1 female (heterochrome); Ujung Kulon, 190 GA, 20 Sep 1984, 1 female (heterochrome).

According to Lieftinck (1954) *Neurothemis fluctuans* is rare and extremely local on Java, while *Neurothemis ramburii* is widespread but very local there.

I am unable to identify the specimens from Ujung Kulon; the specimens from Sumatra seem to belong to *N. fluctuans*. It is well known that identification of the genus *Neurothemis* meets many problems in this part of their range. Lieftinck (1954: 151 footnote) mentions hybridization between *N. fluctuans*, *N. ramburi* and *N. terminata*, three species frequently flying on the same site. Lieftinck (1953) records all three species from Panaitan Island, and according to Lieftinck (1954) they can usually be kept apart fairly easily. I have examined large series in the RMNH collection, all identified by Lieftinck, but relevant characters seem to show significant variation between populations. A further study of this complex is needed to judge on the status of these taxa. Also Ris (1911: 567) has expressed his doubts about the specific status of these taxa. An extensive study of the variation of the characters involved (e.g. size of wing marking, number of cubito-anal cross-veins) could contribute

to our understanding of the historical biogeography of this species complex.

Neurothemis terminata Ris, 1911

Java, Ujung Kulon, hills behind Carita, 11 Aug 1985, 1 male; Idem, Cidaon, 190 HB, 15 Sep 1984, 1 male.

A common species on Java. See also remarks under *N. fluctuans* / *N. ramburii*.

* *Neurothemis tullia feralis* (Burmeister, 1839)

Krakatau Is., Anak Krakatau, outer rim, Malaise trap 21-24 Aug 1985, 213 EA, 1 male.

Second species known from Anak Krakatau, and only the second record of this species from the Krakataus (first record: Rakata, 23 Oct 1923). It is rather rare and local on Java (Lieftinck 1934); there are no reliable records from Sumatra. It inhabits marshlands and weedy ponds.

* *Rhyothemis phyllis phyllis* (Sulzer, 1776)

Krakatau Is., Panjang, 192 BB, 3 Sep 1984, 1 male.

Rather common species on Java, probably also breeding in oligohaline waters. The present record is the first of this species from Panjang, and only the second record for the Krakatau islands (first record: Rakata, 1921).

Table 1. Odonata on the Krakatau islands.

Species	Rakata Besar		Rakata Kecil		Sertung		Anak Krakatau	
	Before	Now	Before	Now	Before	Now	Before	Now
Coenagrionidae								
<i>Pseudagrion microcephalum</i>								
<i>Ischnura senegalensis</i>	•					•		
<i>Agriocnemis femina</i>			•					
<i>Agriocnemis pygmaea</i>								•
Libellulidae								
<i>Agriopoptera insignis</i>	•					•		
<i>Cratilla lineata</i>	•							
<i>Raphismia bispina</i>						•		
<i>Acisoma panorpoides</i>	•							
<i>Orthetrum sabina</i>						•		
<i>Orthetrum glaucum</i>						•		
<i>Orthetrum testaceum</i>				•	•			
<i>Diplacodes trivialis</i>	•	•	•			•	•	•
<i>Crocorthemis servilia</i>	•		•			•		
<i>Neurothemis terminata</i>	•		•			•		
<i>Neurothemis tullia</i>	•							•
<i>Pantala flavescens</i>	•				•		•	
<i>Rhyothemis phyllis</i>	•				•			
<i>Tramea limbata euryale</i>						•		
<i>Macromdiplax cora</i>						•		
Aeshnidae								
<i>Anax guttatus</i>							•	
Total number of species	10	1	4	2	13	1	1	3

Camacinia gigantea (Brauer, 1867)

Java, Ujung Kulon, Pulau Peucang, 190 AM, 18 Sep 1984, 1 female.

Widespread from Burma and Assam eastwards to Eastern New Guinea. Usually rather uncommon, restricted to low altitudes in non-cultivated areas.

*** Pantala flavescens** (Fabricius, 1798)

Krakatau Is., Sertung Spit, at camp, 310 D, 18 Aug 1985, 1 male; Idem, Sertung forest, 310 E, 19 Aug 1985, 1 male.

A very common circumtropical species and strong flier.

DISCUSSION

The dragonfly fauna of the Krakataus is only a poor representation of the fauna of the 'mainlands' of Java and Sumatra. This can even be demonstrated with the present data, but especially when all data available about the fauna of Java and Sumatra, or even those about that of Panaitan Island, are compared with those from the Krakataus.

The reason for the high turnover rate of the species involved must be the fact that there is hardly any water available as breeding site for freshwater invertebrates. Most specimens collected should be considered as stragglers from Java or Sumatra, and must have reached the Krakataus by active flight or transported by the wind. The fauna of Panaitan Island (c. 150 km², c. 10 km from the mainland of Java) was found to be far more mature in 1951 and also included several stream-dwelling species. Lieftinck (1953) concluded that the dragonfly fauna of that island was not entirely composed of species that had reached the island accidentally, but that certain species must have inhabited it since the time it was a part of Java. Not all species found on the Krakatau islands (table 1) were also collected on Sumatra and Java by the present expeditions. However, they are all eurytopic or inhabiting coastal biotopes, where they are common, and usually also abundant, in southern Sumatra and/or western Java (based on Lieftinck 1954).

Nevertheless, in future one may expect an indigenous dragonfly fauna on the Krakataus when the forests have become more mature. Several highly specialized species of Zygoptera as well as Anisoptera, are known as breeders in phytotelmata, e.g. treeholes of decaying logs, bamboo stumps, or waterholes at the leaf-base of *Pandanus* (cf. Corbet 1983). Examples of this fauna are the members of the libelluline genus *Lyriothemis* Brauer (cf. Lieftinck 1954, Kitching 1986), which breed in water-filled treeholes, and the pseudagrionine genus *Amphicnemis* Selys, supposed to breed in water at the leaf-bases of *Pandanus* trees. This kind of Odonata may find a breeding site on the Krakataus in due time. It may even be true that representatives of

this kind of dragonflies already inhabit the Krakataus, since most of them are very hard to collect by their inconspicuous behaviour.

From a zoogeographical point of view it is of interest to mention that the fauna of the Krakataus seems to be Sumatran rather than Javan, contrary to the Panaitan Island.

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REFERENCES

Corbet, P. S., 1983. Odonata in Phytotelmata. In Phytotelmata: Terrestrial plants as hosts for aquatic insect communities (eds. J.H. Frank & L.P. Lounibos). pp. 29-54. Marlton, New Jersey: Plexus.

Dammerman, K. W., 1948. The fauna of Krakatau 1883-1933. Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, afd. Natuurkunde (Section 2) 44: i-xii + 1-594 + plate 1-11.

Davies, D. A. L. & P. Tobin, 1984. The dragonflies of the world. A systematic list of the extant species of Odonata. Volume 1. Zygoptera, Anisozygoptera. - Rapid Communications Societas Internationalis Odonatologica, Supplement 3: 1-127.

Davies, D. A. L. & P. Tobin, 1985. The dragonflies of the world. A systematic list of the extant species of Odonata. Volume 2. Anisoptera. - Rapid Communications Societas Internationalis Odonatologica, Supplement 5: 1-151.

Fraser, F.C. 1933 Fauna of British India including Ceylon and Burma. Odonata. Volume 1. Taylor & Francis, London.

Jacobson, E. R., 1909. De opneming van de Krakatau-groep in Mei 1908. 5. De nieuwe fauna van Krakatau. - Jaarverslag van den Topographischen dienst in Nederlandsch-Indië 1908: 192-206 (sep. 43-57), 1 table excl.

Kitching, R. L., 1986. A dendrolimnetic dragonfly from Sulawesi (Anisoptera: Libellulidae). - Odonatologica 15: 203-209.

Lieftinck, M. A., 1934. An annotated list of the Odonata of Java, with notes on their distribution, habits and life-history. - Treubia 14: 377-462 + 1 plate.

Lieftinck, M. A., 1935. A synopsis of the Odonata (Dragonflies) of Sumatra. - Miscellanea Zoologica Sumatrana 92-93: 1-23.

Lieftinck, M. A., 1953. Notes on some Odonata from Panaitan Island, Sunda Strait (West Java). - Idea 9: 51-56, 2 maps.

Lieftinck, M. A., 1954. Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. - Treubia 22 (Supplement): i-xiii + 1-202.

Ris, F., 1911. Libellulinen 5. - Collections Zoologiques du Baron Edm. de Selys Longchamps 13: 529-700 + plate V.

Ris, F., 1912. Über Odonaten von Java und Krakatau gesammelt von Edward Jacobson. - Tijdschrift voor Entomologie 55: 157-183 + plate 6-8.

Ris, F., 1916. H. Sauter's Formosa-Ausbeute. Odonata.

(Mit Notizen über andere ostasiatische Odonaten). – Supplementa Entomologica 5: 1-81, figs. 1-47, plates 1-3 excl.

Schmidt, E., 1934. Odonata der Deutschen Limnologischen Sunda-Expedition. I. Imagines. Mit Beschreibungen zweier neuer Ictinus aus Celebes und Neu-Guinea. – Archiv für Hydrobiologie, Suppl. 13: 316-397, figs. 1-93, tabs 1-3, tabs 1 + Plate 14-17 excl.

Simkin, T. & R. S. Fiske, 1983. Krakatau 1883. The volcanic eruption and its effects. – Smithsonian Institution Press, Washington DC: 1-464, figs. 1-139, plate 1-16 excl.

Thornton, I. W. B. & T. R. New, 1988a. Freshwater communities on the Krakatau Islands. – Philosophical Transactions of the Royal Society of London (Series B) 322: 487-492, fig. 1, tab. 1.

Thornton, I. W. B. & T. R. New, 1988b. Krakatau invertebrates: the 1980s fauna in the context of a century of recolonization. – Philosophical Transactions of the Royal Society of London (Series B) 322: 493-522, figs. 1-2, tabs. 1-10.

Thornton, I. W. B. & N. J. Rosengren, 1988. Zoological expeditions to the Krakatau Islands, 1984 and 1985: General introduction. – Philosophical Transactions of the Royal Society of London (Series B) 322: 273-316, figs. 1-24, tabs. 1-10, plates 1-14 excl.

Yukawa, J. & Yamane, S. 1985. Odonata and Hemiptera collected from the Krakatau and surrounding islands, Indonesia. – Kontyû 53: 690-698.

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Data for primary types of previously described species follow directly the reference of the original description as:

Elachista subnitidella Duponchel, [1843]: 326, pl. 77: 8.
Lectotype ♂ [designated by van Nieuwerken & Johansson 1987: 471]: [Austria, Vienna region], Duponchel coll., Genitalia slide EvN 2522 (MNHN) [examined].

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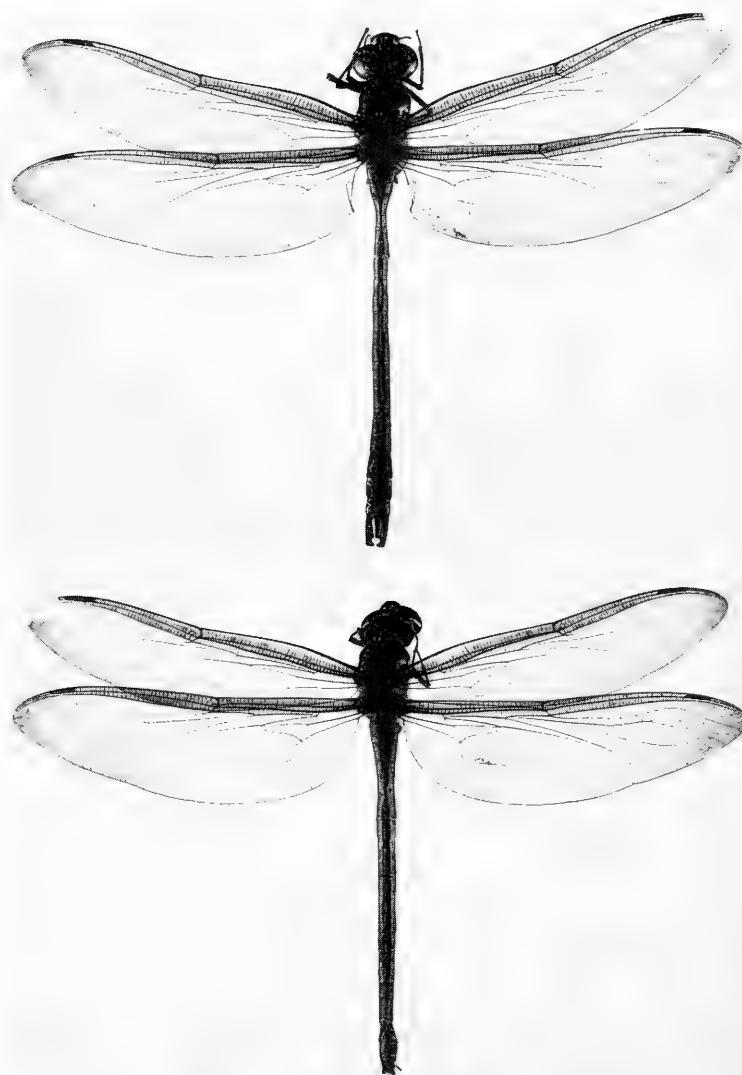
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CORRIGENDA

The figures 72-73 of the paper by J. Belle, A revision of the New World genus *Neuraeschna* Hagen, 1867 (Odonata: Aeshnidae) published in volume 132 (2), page 283, unfortunately are depicted too large. The reproductions below show these figures in the correct size.



Figs. 72-73. — *Neuraeschna titania* spec. nov., ♂ holotype; 73, *Neuraeschna titania* spec. nov., ♀ paratype from same locality as holotype.

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